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THE COW IN INDIA

IN TWO VOLUMES

VOL. I.

BREEDING—DAIRY INDUSTRIES



SATISH CHANDRA DASGUPTA

KHADI PRATISTHAN

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THE COW IN INDIA

Vol. I—Breeding—Dairy Industries.

Vol. II—The Body of the Cow, its
Diseases and Treatment.

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F O R E W O R D.

One of the first and best pupils of the late lamented Dr.P.C.Ray, Shri Satish chandra Dasgupta is a fit person to bring under one cover all the available literature on the cow rightly called the Mother of Prosperity. By convincing arguments based on copious reading of which he has reproduced the relevant parts in the volume, the author has dispelled the belief held even by learned men that India's cattle are a burden upon the land and divides its production with the people to the latter's detriment. He shows the usefulness of the cow as the giver of milk, the producer of draught bullocks, the manurer of our fields and after death the giver of her hide and bone. He proves the superiority of cattle over the engine for ploughing the fields of India. He establishes the inevitable connection and interdependence between the cattle and other

animal life, the earth and man. Lastly he proves the superiority of the cow over the buffalo, not so that the latter should be killed off or starved out but so that the buffalo should not be favoured at the expense of the cow as is done at the present moment. I commend the volume to the lover of the cow as also to every one who would learn that the slaughter of cattle for food is a pure economic waste and know how he can turn the cow into a giver of plenty instead of being the giver of scanty which owing to criminal negligence she has become today.

It will interest the reader to know that the author wrote the whole volume during ^{recent} his imprisonment.

Mahabaleshwar, |
20th May 1945. |

m k Gandhi

PREFACE

The Cow in India was written in the Alipur Central Jail. This Jail is my old place and as soon as I entered it in 1942, I was welcomed by the Jailor and was requested to take charge of the Dairy where I had worked previously. For the first six months I worked for the Dairy and gave the rest of my time to translating the "Home & Village Doctor" into Bengalee. When this work was done I took up the work of writing a book on cow-keeping. It was difficult to procure existing literature on the subject. I was a convicted prisoner, and there was the rule for not allowing more than five books at a time to a prisoner, as laid down in the Jail Code. I needed current literature and scientific Magazines on animal husbandry. As I was working for the Jail Dairy, I was subsequently permitted to bring in books without restriction about their number.

The Jail Dairy had 70 heads of cattle. It had been in a fine form when I left it years ago, when by my labours it had been lifted from a miserable condition. All that was gone now. Continued neglect and ignorant handling had worked havoc with the herd. For the past two years the animals had been kept on inadequate but costly ration; and to add to the misfortune, all green food had been withheld from the animals. The animals were rickety, the calves died, either before or after delivery; some were

blind, there were cases of delayed placenta, of abortion, of sterility—all results of mal-nutrition. There was strenuous work ahead. The Jail authorities gave me every facility in my endeavour for placing the Dairy on a better footing. I was astonished to find how the herd responded to the new treatment. Calf mortality vanished, the cows put on a glistening coat of fur, the calves were putting on flesh. The oestral period became normal and in six months the dairy again became a presentable thing. The cows made up quickly the setbacks they had received. The laboratory attached to the Jail hospital was taken advantage of for my work, where I could get not only all the medicines that I needed but I could work with the microscope also. The Jail became for me a Research Institute on cow-keeping.

It was in the Jail Dairy that I could scientifically experiment with the construction of feeds and find out the most suitable way of keeping cows in health on the basal ration of rice-straw by correcting its defects. It was here that I successfully developed a formula for feeding the calves on the minimum quantity of milk and yet provide for the full requirement of the growing calves and heifers. I brought up the Haryana calves on about 350 lbs. of milk in a lactation and found that the calves were putting on flesh and bone at the rate of 8 pounds per week. What milk I was allowing with such satisfactory result on calf growth, aided by proper concentrates and mineral mixture, any villager could allow, proportionately to the birth weight of the calves.

When I commenced writing the book, there was slaughter of cows in the land, but it did not assume the proportion that it did afterwards. I had to combat the established official propaganda that without slaughtering there was no hope for bettering the condition of the cow in India. I have shown that the theory is mistaken and is based on wrong premises. But today nothing need be argued out against cow slaughter as a measure for the improvement of the cow. The demand for slaughter is more than the birth rate can meet. There is too much of slaughter today and who can say that the cattle population has fared better on account of the slaughter now going on? On the contrary, thoughtful men are despondent about the future of the Indian cattle. Slaughter is creating a very large gap in our cattle population. With all this slaughter, the condition of the remnant cows has not improved, as it should have done if theories of the economists were correct. In the pre-war days cows used to be slaughtered merely for their hides. A dry cow was worth as much as her hide was worth. The urge for slaughter came from the tanneries, Indian or foreign. The hide was the main product and meat was a by-product, often thrown away for want of any use, in places where slaughtering was wholesale on market days for the hide markets. Now, all that has changed. A cow is now worth its weight of flesh. It is slaughtered for flesh and the price of meat determines the price of an animal. If a cow which is now worth Rs. 150/- is slaughtered, its hide may fetch Rs. 12/- or only 8 per cent of the

cost of the animal, as against the hundred per cent it used to be.

I have dealt with the favourite theories of the economists about cow slaughter and urge for *himsa* in the Introductory portion.

In the matter of the competition from buffalo I have put in a Chapter—"Cow vs. Buffalo." I dealt with the subject there in a general way. But as I progressed with the book, as I wanted to find out some way for helping the cow from her place of present degradation, I found every attempt was futile, because of the competition of the buffalo. Turn whichever way I like, the buffalo stands between the cow and its improvement. There was obstacle observable at every step and in every direction, coming from this animal, the buffalo. It is, therefore, that after I had finished with the Chapter—"Cow vs. Buffalo"—newer things came up before me. The reference to buffalo obstruction is shown throughout the book and a chain of paragraphs for reference has been put at the end of the Chapter on "Cow vs. Buffalo", where the problem of the competition from the buffalo has been dealt with from newer view points. The most astounding fact which struck me was that when we consider the vitamin value of cow and buffalo fat, buffalo-ghee seems to go out of the picture as ghee and take the place with lard or other animal fats. The carotene-vitamin value of buffalo-ghee is less than 2 units as compared with 21 units of the cow. And ~~these~~ 2 units are of a evanescent nature. On this consideration buffalo-ghee

comes down to the level of an ordinary fat or oil. Why then should people buy buffalo ghee, while practically the same nutritive value as that of buffalo-ghee may be obtained from, say, cocoanut oil ?

Gandhiji has very forcibly spoken about the inadvisability of fostering the buffalo. But he had not put all the arguments that came to me in my endeavour to make some room for the cow to live decently. Gandhiji's warning will come with added force after the newer facts are considered.

The book is no mere collection of formulæ for feeding a cow, or directions for obtaining the utmost milk from a cow. Cow-keeping is a *yajna*, and I have tried to show why and how it is so. I had to be argumentative. I was writing against the current conceptions about bettering the cow. Mere assertions would have been of no avail. The Royal Commission had taken the field and mobilised official and educated Indian opinion in the channel it wanted to mobilise it. It had given a wrong lead and the scientific men and the economists had accepted the Royal Commission's findings. I had to fight against the current belief. For this I had to quote extensively from the Royal Commission's Report and also from Wright's and Voelcker's Reports on the subject. I had to find space for these and more. I had to quote expert opinion for the findings I arrived at.

As regards nutrition, much new ground had to be covered and scientifically presented to readers in a form in which a lay man could intelligently follow the analysis of the fodders and construct a square feed

out of materials available for him. For all these considerations the bulk of the volume has become what it is.

I believe that the cow can be lifted from its down-trodden condition even from today. I believe that the milk yield of the average cow may be increased by 60 per cent or more at once if people will intelligently work for it. The pre-war value of the cow products and labour was a thousand crores of rupees, and the value of milk was 300 crores. The figures may be enormously increased and national wealth proportionately augmented. It is for the constructive workers in the village to profit by the knowledge attempted to be imparted through this volume and take up this most responsive animal—the cow—for better use than she is being put to now, and lift her up. This will amount to lifting up the nation.

It has been possible for me to write the book in the way that I have done on account of the kindness that I received from some of my friends, political and other prisoners, in the Jail who took up my directions and faithfully and enthusiastically carried them out in practice in the Jail Dairy in the matter of feeds, diseases and their treatment. They chose to have Dairy duty in the Jail and did all the menial or manual work from cleaning and feeding to chaff-cutting required in a Dairy.

After I had come out of Jail, S. J. Y. M. Parnerkar of the Sevagram Go-Seva Sangh, an old friend of mine, took a fancy to the manuscripts and offered to help me in making them ready for the press. He

devoted much time to the work and went through the entire manuscripts and made some very valuable suggestions. It was not possible for me to attend to the printing or go through a single proof while the manuscripts were in the press. I depended upon our friend Sj. Suresh Chandra Deb for seeing the book through the press, and he has been at it, true to his amiable and pains-taking habit. Sardar Bahadur Sir Datar Singh and other friends helped me by the loan of books.

There was much difficulty about securing paper, and when, after all, paper was obtained came the Government restriction on the press. The necessary permit to go on with the printing was obtained after sometime. These caused a few months' delay.

Some of the illustrations have been taken from the "Agriculture and Livestock in India", "The Indian Farming", and the "Indian Journal of Veterinary Science & Animal Husbandry", and some other books, and they have been acknowledged in their places.

Paragraphs have been numbered in the book and for reference to any particular para, the paragraph number in thick type has been put in the text indicating reference to that para. In the detailed contents the references are to paragraphs while the reference in the index is to pages.

Khadi Pratisthan, {
10th April, 1945. }

SATISH CHANDRA DASGUPTA.

THE COW IN INDIA

VOL I.

BREEDING—DAIRY INDUSTRIES

[IN FOUR PARTS AND THIRTY CHAPTERS]

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THE COW IN INDIA

INTRODUCTORY

Place of the Cow in Planning for Soil, Plant, and Animal Husbandry

There are a little less than 400 millions of human beings in India, and there are a little over 200 millions of cows and buffaloes in India. Very roughly, for every two of the former there is one head of cattle. India is said to possess one-third of the total number of cattle of the world which is computed to be near about 600 millions. There is no single country which has even much over one-third of the cattle of India. India is particularly blessed in possessing this very large number of cattle. The economic value of the cattle labour and the cattle products of India is gigantic, amounting to rupees one thousand crores. There is no industry anywhere the value of the output of which mounts to a thousand crores.

Dr. Wright pointed out that the value of milk and milk-products of India goes up to three hundred crores. The significance of the worth of (pre-war) 300 crores of rupees is roughly equivalent to the (pre-war) value of India's total of export and import trade or of the total output of rice, and is three to four times the value of the total output of wheat.

Yet one cannot be happy over these gigantic figures. The two hundred odd millions of cattle are

under-fed and are, therefore, unable to give the work or the milk they should give. Because the draught-cattle are weak a larger number has to be kept. The excess over what would have been necessary to perform the required cultivation, consume the fodder which, if given to the minimum required cattle, would have better fed them and brought out better progeny and more milk. This is the trend of thought in the matter of the number of cattle. And for all this the blame is put on the patient back of the cultivator who is depicted as a symbol of ignorance, hide-bound to a false sense of religion, in as much as cow-slaughter is not encouraged by him. Instead of stopping to look at the question from the constructive side, instead of finding out a remedy, the modern economist regards the problem as insoluble, because of the cultivator, for his ignorance, because of his religious sentiments. This is the typical outlook of the modern economists who are out to plan a better India. Most reputed writers repeat these and the novices take these postulates for granted and growl at the cultivator.

I do not think so. I think quite differently. I believe that the starving condition of the cattle is due to maladjustments, the blame for which cannot be laid on the cultivators. The cultivators are good. They are victims of maladjustments in which they have had really no hand. They do not know how to protest either. The accusations against them are theoretical, these do not reach them, and even if these accusations did reach them they could not have given any reply except by their work and by their mute

sufferings, and by the sufferings of their equally-mute animals.

Dr. Radha Kamal Mukerjee is an authority on economics, and his words deservedly command respect not only in India, but outside India also. The effects of what such a person writes, whether in condemnation or praise, cannot be ignored. In one of his recent publications—"Food Planning for 400 Millions" (1938), the subject of cattle industries has been dealt with. Here he repeats the stereotyped accusations against the cultivator. As typical of what has been recorded in the Report of the Royal Commission on Agriculture, and as typical of what is daily repeated in the writings of economists and social reformers and planners for India, Dr. Radha Kamal's opinions are worth quoting.

"Economic Folly" in Increasing Scrub Cattle

"The live-stock is thus fast and progressively increasing and deteriorating not only in many districts in Bengal but also in the densely-populated parts of Orissa and Madras, in the eastern districts of the United Provinces and in north and south Behar. Economic folly cannot go further. But the folly is being repeated by small holders who have the largest portion of useless cattle that drain on their meagre resources."

—(P. 141)

How the cultivator deals with the problem

But the small holder, in the off-season, when there is no cultivation and there is no fodder, sells off his

cattle. Dr. Mukerjee here again blames the stupid cultivator for this folly in selling off the cattle which he cannot maintain for the season, as under :

“The small holder has his own way of meeting the fodder shortage; he sells his cattle in the beginning of summer, as soon as he can spare them, and buys new ones as the agricultural operations begin, thus avoiding the expense of feeding them at the time when fodder and grazing is shortest.”—(P. 142)

One would suppose that an economist would praise the cultivator for his good sense and his keen perception of money-values. He does not allow his sentiment to stand between the disposal of his beloved cattle and saving money that would have been usually spent in maintaining them. Such an wise cultivator is likely to be appreciated by the economists for having set money-value before other considerations.

“But this sometimes involves great loss for him and profits for the peripatetic cattle-dealers who swarm about in the country-side when the monsoon begins.”—(*Ib.*)

Decay in men and animals

But the gravamen of the charge is yet to come.

“Since fodder and pasturage are deficient, large numbers of inefficient cattle which are preserved in a state of semi-starvation consume fodder that is sadly required for the better cattle. Over-grazing

leads to the deterioration of the grass-lands, erosion of their surface soil and the loss of the nutriment value of the fodder, which often acquires harmful quality on account of deficiency of certain mineral contents such as phosphorus and auximones. On the other hand, surface tillage due to the lower strength of the cattle and inadequate manuring lead to the deterioration of arable land. Mal-nutrition thus pursues its harmful course in an ever-widening vicious circle; the cultivator is too often ill-nourished and ravaged by disease which is commonly the result of his ill-nourishment. Obviously, the poorer the beast is fed, the poorer in food-value must be its produce."—(P. 143)

Hindu sentiment aggravates the difficulty

"The numbers of cattle have become so large and their efficiency has fallen so low in India as results of the process having advanced so far that the task of reducing the number of useless animals and of reversing the process of deterioration is now extremely difficult. In several ways social and religious sentiments which belonged to more spacious times in the past, and have now become obvious misfits, have conspired to aggravate the difficulty."—(P. 144)

"To kill a bullock or a cow is a deadly sin in Hinduism. The orthodox Hindu often objects to sell, even in extreme circumstances, because sale is usually to a butcher and leads to the slaughter-house."—(*Ib.*)

Here the author refers to a writing of Darling who says that in the north of the Jhelum in the Punjab there are few Hindus and there, in this area, cattle-breeding is as easy as it is difficult elsewhere.

“Unless the Hindu sentiment is abjured altogether the Indian cultivators cannot take a practical view of animal-keeping and will continue to preserve animals many of which are quite useless from birth to death, the number of these being greatest among the small cultivators who can afford it least.”—(P.145)

And ahimsa also

Finally, *ahimsa* is brought out as the prime culprit to receive the fullest measure of condemnation for the wretchedness of animals and the wretchedness of the human beings who populate India !

“India, with her human burden of 377 millions and her 48 millions of ‘average men’ estimated without food, can ill afford to add indefinitely to her enormous bovine population of 214 millions at the rate of 20 percent per decade, and permit the cult of *ahimsa* to get the better of human food resources.”—(P. 153)

Muslims and the cow

His attack on that sentimental person, the Hindu, who often objects to sell his bullock even in extreme circumstances because selling means sending the cattle to the slaughter-house, is one-sided. This

is a great offence, no doubt—this objection to sell! But are the small cultivators all Hindus? Dr. Mukerjee knows that there are districts where about ninety percent of the population are Mahomedans—in north Bengal and in some areas of East Bengal, for instance. There are groups of villages inhabited exclusively by Mahomedan cultivators who have no religious objection to cow-slaughter and who do slaughter cows. He has himself cited the case of the small cultivator who sold off his cattle during the dry and inactive season. What about these people? What about that half of Bengal which is very predominantly Mahomedan? Are they better-off? Does the fact of there being 108 cattle per 100 acres of sown area in Bengal apply to them? It does. The Mahomedans are no better than the Hindus in the matter of providing for cattle nutrition and in the matter of the number of cattle maintained, inspite of their freedom from the religious scruples which are supposed to bind down the Hindus. As a matter of fact, the Hindus sell their cattle and shut their eyes to the fact that the cattle are going to the butchers. I write from knowledge of facts. Therefore, this cry against the religious sentiment is a false cry. The cattle are deteriorating not because of Hindu religious sentiment and not because of the fact that they refuse to sell useless cattle. There must be reasons, and whatever those reasons may be, the fault does not lie with *Ahimsa* as has been improperly laid on it from the Royal Commission down to the latest writers on economics and animal husbandry, and which

has filtered down even to the writers of our school text-books.

Himsa and Ahimsa irrelevant here

The cattle are being sold for slaughter; they are being sold at the price—the bare price—of their hides and for their hides only, and the Hindus and Mahomedans are selling them equally to the extent that there is a demand for their hides. Slaughtering increases and decreases with the fluctuation of the hide-market. One slaughter-house at Calcutta slaughters 300 cows daily. One slaughtering-field near Agra disposes of 2,000 cows daily, and here, at this last place, slaughtering is for the hide alone as the meat here is of little or no value. The economists must be knowing these facts. There is plenty of *himsa* in the land and no economist need worry about it ! The cattle are poor and the men are poor not because of the prevalence of *ahimsa*, but because of *himsa* in the form of ignorance and a wrong lead. But this wrong, this untrue statement about religious prejudice hampering the improvement of the cattle, is repeated *ad nauseum*. In the very preface of the "Food Planning etc" of Dr. Mukerjee, there comes the condemnation.

No constructive programme presented

"The improvement and cultivation of fodder crops will be futile, if not actually harmful, if the peasants continue their present attitude towards the maintenance of uneconomical and useless

cattle, which represent the staggering figure of 125 million heads.”—(Intro. XI)

The Royal Commission long ago had said so and expressed the fear that if you improved the fodder position there would be more reproduction of cattle. Both the Royal Commission and the economists are agreed upon a do-nothing policy till wholesale slaughter is introduced and maintained. Because, if you give more food more hungry cattle will come into being, and there will be no solution of malnutrition and over-population !

This is what I have called a do-nothing position. This is applied by the economists not only to the so-called over-stocking problem of cattle but also to the over-population of men. If more food is produced there will be more hungry mouths coming into existence by unchecked reproduction. Therefore, sit tight till the Indians learn to use contraceptives as a universal routine practice !

In vain one searches the writings of the economists and the findings of the Royal Commission for a lead for alleviating the distress of cattle and men. Their pet theory, and a false theory at that, has lead them to a position from which they can only condemn but cannot show light.

Vegetable and animal food

Dr. Mukerjee, typical of the modern scientist and economist, has devoted a chapter on “The Triangular Conflict : “Man—Land—Cattle—” in the same book. The author sees a struggle in nature, amongst men

in land and amongst cattle for eking out existence. The area of land is limited, and on the same area both men and animals are struggling to live. Vegetarianism has been born, according to the author, out of this struggle. Nutritional scientists have shown that the yield of vegetable food per acre of land is greater in caloric value to animal products got out of the same acre.

	No. of acres.		
	Crop	Pasture	Total
Potato.	0.76	...	0.76
Corn meal	0.79	...	0.79
Wheat flour	1.45	...	1.45
Milk	2.35	1.60	3.95
Pork and lard	3.70	0.70	4.40
Beef	11.30	2.50	13.80—(P.124)

From this table the author, Dr. Mukerjee, has concluded that it is cheaper to obtain the calories for maintenance from vegetables than from animal products, and asserted :

“The reason, therefore, why the eastern countries ordinarily do not and cannot favour animal products, cannot be exclusively religious. Vegetarianism is ultimately a result of heavy population pressure”.—(P.125)

India's population through the centuries

In a table the author has shown that in 1,600 A. D. there was a population of 100 millions of people in India; in 1750 it was 130; in 1850 it

was 150, which have multiplied $2\frac{1}{2}$ times between 1850 and 1935, in less than a century, to 377 millions.

Year		Population in millions.	
1600 (Moreland)	...	100	Millions.
1750 (Shirras)	...	130	„
1850	...	150	„
1872	...	206	„
1881	....	254	„
1891	...	287	„
1901	...	294	„
1911	...	315	„
1921	...	319	„
1931	...	353	„
1935 (estimated)	...	377	„—(P. 3)

Theory of vegetarianism & the past

If India's acreage supported only 100 millions people in 1600 A.D. and was supporting 374 millions in 1935, the population has increased 3.73 times during these centuries. The pressure has been 3.73 times. If people are found to be vegetarians in India today on account of population pressure, that pressure was non-existent 400 years ago. But were they less vegetarians then? And going back to the time of Asoka—what must have been the population in that pre-Christian era? If it was 100 millions in 1600 A.D., it could not have been more than, say, 10 millions 1600 years earlier or for the matter of that in 300 or 600 B.C. The people of India, in those times, in the days after the Buddha or Asoka, must have been gorging themselves, according

to Dr. Radha Kamal's theory, with beef. And upon such materials food planning for India is being based. But the point that has been brought out of this cheap vegetarianism is that on account of this hunger for acreage, for food, a struggle between man and cattle has come into being.

A conflict and a paradox

"It is needless to state that in the United Provinces, Bihar and Orissa, and Bengal the cattle cannot obtain their minimum feeding requirement at all. The competition of both the human and bovine population for maintenance on small holdings, which must yield both food and fodder crops, has resulted in the steady deterioration of animals' food supply and of their breed and efficiency."—(P. 130)

And then, after the enunciation of the struggle between man and cattle for maintenance on the same small holding, the paradox is stated that the more the pressure of men on soil, the more is the number of cattle there. The author has rested on merely stating the paradox, but has not solved it.

"One might expect that heavy population density thins out the bovine population. But, it is one of the striking economic paradoxes in India that the Provinces which have the smallest crop area *per capita* maintain the largest number of cattle. In fact, the density of the bovine population per crop area varies directly with human population density and inversely with the crop area per person.—(*Ib.*)

The paradox is there if the hypothesis of the triangular struggle between land, man and cattle is correct. But the theory of the struggle of man-land-cattle is incorrect, and there is no paradox.

Not conflict but inter-dependence

What has been stated as a paradox is no paradox, if things are looked more closely into. Soil and plant, cattle and men, are all inter-dependent. Soil is the mother and all the rest are her children. She is the nursing mother—our mother earth—and there is no conflict in her for things of her creation. She procreates, nurses, develops, causes decay and kills and takes the body again to herself. This cycle is going on. Men understanding the cycle put themselves in tune with her and her creation, and enjoy the harmony which is in nature.

Man and cow have become, by long association in India at least, a composite animal. One cannot do without the other. No wonder, with more men there will be the need for more cattle. And, if in certain Provinces there are proportionately more cattle than in some others, greater dependence of men on cattle in these congested areas is the reason for such an arrangement. When there are more men in an area, they have to rely proportionately more on the cattle for maintenance, in the peculiar circumstances of the times. When this harmony is discovered the remedy to maladjustments also, where they exist, is found.

Because of the hypothesis of this conflict which is the corollary of the exploded hypothesis of the struggle for existence in men, things appear in a wrong light, and wrong theories are delivered for the correction of maladjustments. The whole planning of Dr. Mukerjee, set forth in the book—"Food Planning for 400 Millions"—is a planning for deprivation and not a planning for creation and adjustment, because of his basic theory of conflict between man-land-cattle.

India, according to Dr. Mukerjee, is over-populated with human beings and cattle. He does not mention plants. A big gap is thus left as to whether the land is over-populated with plants also or not. This seeming over-population of cattle and men brings food shortage for both, and Dr. Mukerjee in his book set out to plan food supply for both men and cattle. His theory of land-man-cattle conflict leads him to seek to allay this conflict by the process of elimination. For the cattle his prescription is that the number should be ruthlessly reduced and kept reduced by continuing to eat them up. The religious prejudices against cow-slaughter is to him the prime offender. This, in his opinion, should go, otherwise all progress remains blocked up. Having solved or cut short the problem of the over-stocking of cattle, Dr. Mukerjee proceeds to deal with the over-population of man in a similar way. There is too much increase of population, and the excess, according to him, should migrate, and this not being quite feasible, procreation must be regulated by the extended use of contraceptives.

“Need of country-wide birth-control propaganda.”

“The introduction of improved seeds, fertilizers and implements, change in marketing methods or even a reform of land tenures, these are all thwarted in India by the fractionalisation of holdings and cheap and inefficient labour in the country-side, which are the indirect results of population increase. On the other hand, mere increase of production cannot now solve the problems at present inherent in the situation, such as too low a standard of living, too high a proportionate cost of labour and crop yields, which should be increased.....Unless some check is placed upon population growth, any other remedy tends to be only temporary,.....for population will rapidly rise again to the maximum number of persons the land will support. The offensive against illiteracy is similarly baffled because population out-runs the capacity of education.”—(P. 216)

The ideal for the economist is the small family in enjoyment of all the good things of the world. The family has to be limited. The limit to the size of the family has not been chalked out but can be guessed—it must be man and wife, and no burdens.

When extended and universal use of contraceptives has armed the people with the means of sexual enjoyment without taking the responsibility which is the natural outcome of such enjoyment, the people are not likely to be satisfied with that limited enjoyment alone. More railway facilities, aeroplane

facilities, cinemas for all, are in the line to come up, and necessarily yet more restriction of the family and of the cattle. The cattle gradually will be secondary to mechanical means of cultivation and will be asked to be extinct for draught purposes.

Law of increasing returns.

The Malthusian law of diminishing returns is said to be operating amongst the superstitious and the unreasonable and the uneducatable cultivators of the small holdings in India. But if things like the use of birth control mechanism become successful, the law will operate in a reverse direction, when the law of increasing returns will operate. But it is forgotten that the more increased becomes the area of holdings there will be the more hunger for yet more extended holdings and of enjoyments. With the growth in the size of the farm will be the diminution of the number of human beings per square mile.

Canada provides an example.

"In Canada the number of workers per 1,000 acres of cropped land fell from 26 in 1911 to 16 in 1926. Since these data are published, the size of the working population has shrunk still further. This state of things has arisen from the scarcity and dearness of labour, which has naturally led to the study of labour-saving devices."—*Howard "Agricultural Testament",—(P. 17).*

Dr. Mukerjee deplors the cheapness and excess availability of labour. Diminishing their number will

accomplish what has been accomplished in Canada. Only a few men per square mile with machines as servants will be enjoying the good things of the earth till perhaps a racial struggle or a modern super-war for supremacy, and greed for yet greater enjoyments sweeps the greedy men off the earth or an epidemic clears them off for the misuse of economics, hygiene, the social and moral sciences.

The triangular versus the quadrangular theory

All these are in prospect, if the postulate of triangular conflict be accepted and its remedy worked out along the lines developed. I have mentioned that the triangular conflict theory of man-land-cattle left a gap for plants in the natural economy of things. Because this gap was left, therefore, what was harmony in reality took the appearance of conflict and pointed the way to elimination and destruction, perhaps to a dazzling destruction. But if the plant be placed in its proper setting in the natural order, things look soothing. There is too much of cattle population and there is too much of human population on the same patch of soil ; but is there too much of plant population also ? Are we reaping the utmost crop that can be reasonably extracted out of the soil ? The reply decidedly is in the negative, for Dr. Mukerjee himself shows that they obtain twice the yield of crop in China, and three times in Japan as compared with India's. Our country can become like China and Japan in this one matter, in the matter of receiving increased returns from the

9

soil through better cropping. If this be done, the conflict disappears—land-plant-animal-and-man form the four sides of a quadrangle and they all thrive. There is, however, a limit to everything. Ultimately even the soil will fail to respond to the call for more plants. It will be the time then, as it is even to day, for men to restrain progeny not for base or animal enjoyment but in sublimation, in a sacrificial spirit for the good of unborn generations. Men, controlling themselves, will be fit instruments for controlling animal re-production too. But all these will come out of strength. Sublimation will be making men stronger in moral calibre and fitting them better for a higher and yet higher life.

One-ness & harmony in creation

The sages of old, their sacred books—the *Bhagawat Gita*, for instance—all have seen harmony and one-ness of life in soil, plant, animal and man, and directed human beings to base their social conceptions on that one-ness in a spirit of service which is another word for sacrifice, for *yayna*.

Indian civilisation enjoined this cult of *yayna* upon its children, and India thrived and took her position in the galaxy of nations. This civilisation was based upon the conception of the one-ness of life—life in soil and plant, life in animal and man, the same life flowing through all. It is all a question of establishing harmony when the law expounded by the *Bhagawat Gita* or which is the same thing as the law of God or the law of nature, is understood.

Such truths as these are not the monopoly of any particular nation or land. These are universal truths and apply to all lands, to all peoples, and for all times. When this law is understood, and life or social order is tuned to it, then conflict ceases and harmony dawns in life and society.

I have referred to the quadrangular harmony of soil, plant, animal and man. But it is really not any angular at all. You may include any number in its sides. It may be pentangular and hexangular and hepta and octangular harmony till the angles vanish in a circular harmony embracing everything in its comprehensive and universal ambit.

An example from Europe

How the operation of this law of one-ness of life and harmony is today being realised and applied in other lands is worth noticing from an example from Europe. The problem has to be understood. The example of a cattle farm in Germany will help this understanding. Dr. Mukerjee has understood it in one way, and applied his own solution to it. I have brought in his name not as an individual author but as representing a class of modern scientific economists among whom he holds a special place of importance. I hold quite a different view from that held by this school of scientists and economists. The difference is basic. It is, therefore, necessary to place views other than those of mine and place the materials before the readers for their judgment. The views of this school of Indian economists have been

dominating the field of scientific planning up till now, despite the opinions of Gandhiji and others who think along Gandhiji's lines in this matter. Dr. Mukerjee treated the problem of cattle population and also the connected human problem in one way. I shall treat them in another way. It is up to the reader to know both the aspects and make his choice in planning for the future as to how best he may, in his own sphere, deal with the cow. Dr. Mukerjee, by the way, has not shown any practical way ; for he, like all other economists and scientists, opines that it is impossible to change over the Indian agriculturist to the acceptance of a cow-slaughter routine, and as for the use of contraceptives by the masses, no body can hope to see any serious practical change in the near future. The cattle, therefore, are to remain in the future planning practically where they are now. This is a confirmation of the conclusions of the Royal Commission. What follows in this chapter is very necessary in correctly estimating our position with regard to cattle economy, and by association, human economy.

Story of Dr. Bartsch's work in Germany

Dr. G. T. Wrench M. D. (Lond.) took up the subject of improving the health of the people by the use of health-giving food, grown on healthy soil. The health of the soil, of the food and of men using the food, are to him linked up as one. He had identified himself with this cause and came "as a pleading doctor on a visit to India for this purpose."

He contributed an article on this subject which appeared in the *Indian Farming* of December, 1940 ; and another article, a condensed translation of an article by Dr. N. Remer, appeared in the same magazine in its issue of May, 1941. Both the articles of Dr. Wrench are illuminating. The second article deals with the romantic work of Dr. Erhart Bartsch in converting a life-less waste into a health-giving farm with cattle as the central figure.

The article is entitled : "Cattle-keeping as the centre of farm organism."

Description of Marien-hohe

The experiment was conducted by Dr. Bartsch at Marien-hohe in East Germany, lying on a vast lake 100 miles to the south of the Baltic sea. The place was sandy and unfit for cultivation. Strong gales blow and the drying character of the atmospheric condition made the humus into bits which blow away before the gales. Rainfall is slight, being 13 to 14 inches yearly. Such was the force of the gale that blown sand clogged the plant and scoured the young shoots away. Marien-hohe passed from hand to hand of enterprisers who all lost money, being unable to make anything out of it. In 1928 Dr. Bratsch took the farm. There were 150 acres of cultivable land and another, one-fourth of it, of grass land. It included fine wood also. The new owner decided to experiment on the farm in a new way, quite different from that of the previous owners who had brought down from outside whatever was considered to be

necessary in the matter of manure and other requirements. Dr. Bratsch set about to make the dead farm alive with the cattle only as its central figure. He had a legacy of 13 heads of poor, sickly cattle infected with all sorts of diseases. There were cases of tuberculosis and of contagious abortion. Instead of selling off this herd and buying a new set of animals, the owner relying on the life-giving property of the soil under proper treatment, kept this herd which was at the time unfruitful to the extent of 70 percent.

But sick though 70 percent of the 13 animals were, they were allowed to stay on to help the experimenter in seeing how they, these cows, the soil and the plants responded to the new treatment. So, the beginning was simply with these wrecks of cows and a promise not to bring anything from outside into the farm, but allow it to be developed as a self-contained unit.

Growing of fodder—first step

The first care was to feed the cows and grow food for the cows and nothing else. The cows would give manure which, composted, would return to the soil and increase its productivity, giving yet better fodder. This was the starting point.

Cereals were sown for their straw-fodder, and the sowing was interspersed with legumes and green fodder. Nearby was an unfruitful upland where the young animals pastured. Careful thought was given to the selection of tubers and roots for fodder. Potato was

known to be a humus-devourer, and as there was not much humus in the soil, it was discarded in the beginning.

Legumes formed the standard fodder for rebuilding the health of the animals. Manuring continued, and with better fodder-crops better corn-crop followed, although occasional droughts brought all growth to a stand-still. Therefore, hedges and trees were grown to ward off the severity of gales.

Gradually peas, lentils, clover and lucerne became a part of the land which could not be previously grown there. According to Dr. Bratsch, all these were achieved by what he calls the bio-dynamic force. Intensive bio-dynamic manuring was carried on which consisted really of compost assisted by auxine preparations.

Bio-dynamic method of treatment.

By bio-dynamics is meant the utilisation of the forces of living things, a balancing arrangement of plants, animals, birds and insects as found in the everlasting recurrence of the forest and the jungle in nature. Nature is copied and nothing is neglected. Bio-dynamic treatment also included careful composting, helped by special injections of rotted vegetable matter, believed to contain auxines or hormones. Some early-growing crops were sometimes sprayed with a solution of these vegetable hormones.

Pastures were developed which grew lucerne. Pastures were necessary for the health of the cows. Some of the badly-affected cattle were destroyed in

1928. The rest showed the fine effects of the bio-dynamic method of treatment of the farm plants and animals, or the added natural forces of rejuvenation and health. The herd was given a variety of food grown on the soil.

Marked success followed rapidly, and the poorly cattle showed improvement and began to calve. Milk production increased astonishingly, and after some time the whole aspect of the farm was changed.

Fodder changed its character from coarseness to fineness and softness. The result was not brought about by the usual method of coarse dunging but by the use of predigested manure or compost. This compost was a fine material for reviving the soil to its ancient strength and giving life through it to plants and animals.

The land became a true home not only of the cows and their attendants but a home for plants and birds and insects, every one working to help the common object of the blossoming forth of life. Even some of the concentrates given to the cows were grown on the soil. There was an addition, later on, of forty to seventy swine which also received their food from the farm.

"It is always a cause of wonder how right actions work out in their varied way within one organism. If a farm is built up upon an insight into the natural dynamic happenings and living associations of various natural cycles, there is built up from within a powerful unity."

—(Dr. Wrench, *Indian Farming*, Dec. 1940.)

This knowledge was applied to feeding and to the management of the cows. The new heifers were surpassing their mothers in milking performance, and this was not due to feeding great and protein-rich quantities, but to the varied and general goodness of the foods.

Now, there was over-flow of health and, therefore, over-flow of milk which was supplied to the neighbouring estates. The calves became objects of admiration to visitors and passers-by,

“Unity of animal, plant and soil”

“The facts stand before us like a miracle. Out of this sandy floor has come a fount of animal health. The one-time sick herd has acquired a second health.” There were qualities sleeping unrevealed in the sandy soil which came to life at the touch of the magician’s wand of the scientific agriculturist who believed in one-ness of life, who believed in imitating nature and allowing nature to work in her own way for healthy and unhampered growth.”

“The far-sighted believer in life forces attended to plant-growing, and the plants took upon themselves a new and lasting constitutional capacity.”

“Scientific theory asserts that sandy soils are too lacking in acid calcium phosphate to serve animal breeding. This may well be so in the case of those business farms where the unity of animal, plant and soil are not realized. We, fortunately,

have been able to build up this unity out of the coarse and fine workings of nature inspite of the disadvantages of the climate and soil of Marien-hohe, and specially in view of the first four dry years of the new farm's existence, with its, at that time, poor supply of straw and the resulting stall-dung. All the more astonishing it was that without any assistance from outside, without any chalk laid upon the fields and meadows, we got cattle with such strength of bone. It was surprising to find that there was existing in the gravel itself an ideal and practical value quality."—(*Ib.*)

Use of cosmic forces of nutrition

This value quality was developed and utilised at Marien-hohe. The quality passed on to the plants and thence to the animals and to the men living on those plants and their roots, tubers and cereals and also the milk of the cows. The story of Marien-hohe is an illustration of the use of cosmic forces of nutrition brought to bear on soil, plant, animal and man.

What an enlivening picture the story of Marien-hohe creates ! Cannot India under an Indian Dr. Bratsch and his inspirer Rudolf Steiner, also accomplish the miracle of Marien-hohe ?

Dr. Wrench in his article "Health Farmers and Doctors" in the *Indian Farming* cited from some writings of the well-known farmer Sir Bernard Greenwell : "A fertile soil means healthy crops, healthy animals and last and not the least healthy human beings."

"Health is a whole. There is no separate human health, no separate animal, no separate vegetable, no separate soil health, and the way in which this whole can be got and maintained is that every living thing in it after its death should not be treated as waste but be returned to the soil. All dead animal and vegetable matter must be returned to the soil, so as to live again, if the whole or health of life is to be preserved. This is the first rule of life that gives to it wholeness, holiness and health."

—(*Indian Farming*, May, 1941.)

These writings make a refreshing reading as they bring back to India the faith which under Western influence educated India seems to have lost, a faith blooming forth in the eternal gardens of knowledge of the "Upanishads".

The Indian experiments

In line with the work of Dr. Bratsch stands the work of Sir Albert Howard of the Indore compost fame. He has not worked exactly for converting a desert-like soil into a rich garden land with the help of a few cows. But he was working on parallel lines, inspired by the idea that life was one in soil, plant and animal, and that the soil would die when plants and animal failed to return to the soil what belonged to it. The thing that gives life to the soil is compost or organic manure, made by the action of aerobic and anaerobic bacteria on vegetable matter, helped by cow-dung and urine.

Sir A. Howard's story of work in our land at Pusa and at Indore are no less romantic than that of

Dr. Bratsch of Marien-hohe. The basic ideas of both are the same. The latter has described for us his experiments and their genesis in his book—"An Agricultural Testament" (1940). His Indore process has long been known in India and is worked at many places. His process carries no patent rights and he has provided elaborate details of working out, and the application of the method of composting. But, apart from the process itself, the inspiration of Howard and his method of working out forms a piece of literature of amazing interest to all who want to increase soil fertility and improve food quality.

Learning from the peasants of Pusa

Sir Albert Howard came to India as Imperial Economic Botanist to the Government of India in the year 1905 and was attached to the Pusa Agricultural Research Institute. He tells the story of his quest after truth thus in his book "Agricultural Testament" :

"My real training in agriculture then began, six years after leaving the University and obtaining all the paper qualifications and academic experience then needed by an investigator."

"At the beginning of this second and intensive phase of my training I resolved to break new ground and try out an idea (which first occurred to me in the West Indies), namely, to observe what happened when insect and fungus diseases were left alone and allowed to develop unchecked, and where indirect methods only, such as improved

cultivation and more efficient varieties were employed to prevent attack. This point of view derived considerable impetus from a preliminary study of Indian agriculture. The crops grown by the cultivators in the neighbourhood of Pusa were remarkably free from pests of all kinds; such things as insecticides and fungicides found no place in this ancient system of agriculture. I decided that I could do no better than watch the operations of these peasants and acquire their traditional knowledge as quickly as possible. For the time being, I regarded them as my professors of agriculture. Another group of instructors were obviously the insects and fungi themselves. The methods of the cultivators, if followed, would result in crops practically free from diseases; and the insects and fungi would be useful for pointing out unsuitable varieties and methods of farming inappropriate to the locality.”—(P. 160)

“In order to give my crops every chance of being attacked by parasites, nothing was done by way of prevention, no insecticides and fungicides were used, no diseased material was ever destroyed. As my understanding of Indian agriculture progressed and as my practice improved, a marked diminution of diseases occurred. At the end of 5 years’ tuition under my new professors—the peasants and the pests—the attacks of insect and fungi on all crops whose root systems were suitable to the local soil condition became negligible. By 1910 I had learnt how to grow healthy crops,

practically free from disease, without the slightest help from mycologists, entomologists, bacteriologists, agricultural chemists, statisticians, clearing houses of information, artificial manures, spraying machines, insecticides, fungicides and germicides, and all the other expensive paraphernalia of the modern experiment station."—(P. 161) १९१९

In this way Howard discovered that the cause of plant diseases lay in unsuitable varieties or imperfect growing of crops. The pests to him were nature's warning that all was not well. Having found out that it is the diseased soil that draws harmful germs, bacteria and pests, to the crops, and that on a life-giving healthy soil crops are not attacked by the pests, he established that plant disease was due to soil disease. He expounded what this soil disease was.

Soil disease was the denudation of soil fertility on account of non-return to the soil what should belong to the soil—the animal and plant refuses and wastes. The soil produced plants and the animals. The dead plants directly and through manure of cattle and men, feeding on plant or plant products, and the remains of animals, all must return to the soil to keep the health of the soil. This health of the soil is disturbed by the use of tractors and mechanical cultivation.

Tractors do not void manure

"The replacement of the horse and the ox by the internal combustion engine and the electric motor is, owever, attended by one great disadvantage. These machines do not void urine and dung,

and so contribute nothing to the maintenance of soil fertility.”—(*Ib.* P. 18)

Tractors and similar appliances help the robbing of soil fertility and contribute to the development of soil disease and consequently of plant disease.

Artificial manures are contributory to soil disease

“Artificial manures are widely used. The feature of the manuring of the West is the use of artificial manures. The factories engaged during the Great War in the fixation of atmospheric nitrogen for the manufacture of explosives had to find other markets; the use of nitrogenous fertilizers in agriculture increased until today the majority of farmers and market gardeners base their manurial programme on the cheapest forms of nitrogen (N) phosphorus (P) and potassium (K) in the market. What may be conveniently described as the NPK mentality dominates farming alike in the experimental stations and in the country-side. Vested interests entrenched in times of national emergency have gained a strangle-hold.”

“Artificial manures involve less labour and less trouble than farm-yard manure. The tractor is superior to the horse in power and in speed of work: it needs no food and no expensive care during its long hours of rest. These two agencies have made it easier to run a farm. A satisfactory profit and loss account has been obtained. For the moment farming has been made to pay. But there

is another side of the picture. These chemicals and these machines do nothing to keep the soil in good heart. By their use the process of growth can never be balanced by the process of decay. All that they can accomplish is the transfer of the soil's capital to current. That this is so will be much clearer when the attempts now being made to farm without any animals at all march to their inevitable failure."

"Diseases are on the increase. With the spread of artificials and the exhaustion of the original supplies of humus carried by every fertile soil, there has been a corresponding increase in the diseases of crops and of the animals which feed on them. If the spread of foot-and-mouth disease in Europe and its comparative insignificance among the well-fed animals in the East are compared or if the comparison is made between certain areas of Europe, the conclusion is inevitable that there must be an intimate connexion between faulty methods of agriculture and animal disease."

... ..

"These mushroom ideas of agriculture are failing ; mother earth, deprived of her manurial rights, is in revolt ; the land is going on strike ; the fertility of the soil is declining. An examination of the areas which feed the population and the machines of a country like Great Britain, leaves no doubt that the soil is no longer able to stand the strain. Soil fertility is rapidly diminishing,

particularly in the United States, Canada, Africa, Australia and New Zealand. In Great Britain itself real farming has already been given up except on the best lands. The loss of fertility all over the world is indicated by the growing menace of soil erosion. The seriousness of the situation is proved by the attention now being paid to this matter in the Press and various administrations. In the United States, for example, the whole resources of the Government are being mobilized to save what is left of the good earth."—(P. 20)

India and scientific cropping

It is strange that while our economists and scientists in India are chiding their countrymen for not copying the methods of the West, for not utilizing mechanical appliances and scientific manures, for not establishing nitrogen-fixation factories for manuring, the West has already proved itself to be a bankrupt, and the better minds there are looking to the East for remedy from its agricultural practices handed down from times immemorial. Not that every thing done by way of manuring in the East is satisfactory. Far from it. But it contains the germ of truth for development in the right direction. Savants of Europe have found out how to give that direction. It is time for India to have faith in her basic agricultural and animal husbandry practices and improve them in the light of the failure of the West. It is for India to work out the methods of improving soil and animal health along old lines, enlightened

by newer scientific knowledge of composting and bio-dynamics—things which already form the basis of Indian soil plant and animal husbandry, without the cultivators knowing what those sciences were.

Howard sees a life-cycle operating through soil-plant-animal. Soil produces plants. Plants are ingested by animals and men. The plant and animal residues are returned to the soil with the life-giving qualities inherent in them ; the soil receives fresh life, puts forth more leaf and more fruit on plants ; and these return augmented in the next cycle. Thus the life-process goes on. If men put themselves in tune with it they succeed. If they do not, and run to artificial manures, these cannot save them. This life-cycle has to be understood, appreciated and brought to practical utilization. The West, in the opinion of Howard, has hitherto been lacking in the appreciation of this truth, so widely known and acted upon in the East. In the East the soil has been keeping up its fertility and the crops are free from pests.

“All the phases of the life-cycle are closely connected, all are integral to Nature’s activity ; all are equally important ; none can be omitted. We have, therefore, to study soil fertility in relation to a natural working system and to adopt methods of investigation in strict relation to the subject.”—(P. 22)

The Eastern system has stood the test of time

“Such are the essential facts in the wheel of life. Growth on the one side : decay on the other. In

nature's farming a balance is struck and maintained between these two complementary processes. The only man-made system of agriculture—those to be found in the East which have stood the test of time, have faithfully copied this rule in nature."

—(P. 25)

Europe has much to learn from Asia

"In the East cultivation always fits in with the life-cycle in a remarkable way. In the West cultivation is regarded as an end in itself and not as it should be, as a factor in the wheel of life. Europe has much to learn from Asia in the cultivation of the soil."—(P. 35).

Artificials in Western culture

"In almost every case the vegetable and animal residues of Western agriculture are either being completely wasted or else imperfectly utilized. A wide gap between the humus used up in crop production and the humus added as manure has naturally developed. This has been filled by chemical manures. The principle followed,..... is that any deficiencies in the soil composition can be made up by the addition of suitable chemicals. This is based on a complete misconception of plant-nutrition. It is superficial and fundamentally unsound. It takes no account of the life of the soil. Artificial manures tend inevitably to artificial nutrition, artificial food, artificial animals, and finally to artificial men and women."—(P.37)

“In the years to come chemical manures will be considered as one of the greatest failures of the industrial epoch. The teaching of the agricultural economists of this period will be dismissed as superficial.”—(P. 38)

Nature's manure-factory in India.

There is no reason why we in India should, for a moment, be allured by artificial manures. We have known that by composting, leafy matter and stalks, in fact all soft vegetable and animal matter may be made into very superior manure. A tropical sun and rich monsoon over wide tracts of India cause leafy structure to grow everywhere in cultivated or neglected areas, in house corners, along sides-paths and drains, in bushes, in clumps, by river banks and on embankments, on ridges that part field from field. The leaves store the sun's energy and manufacture proteins and carbo-hydrates. These are standing, living manure factories at the command of every peasant. The stumps left after harvesting also are materials for composting in the nature's manure-factory. The peasant has only to collect them and with an admixture of the dung and urine of cows to compost, to make the natural manure-factory product to be converted into humus to be applied to the soil. With such abundant and costless manure factories, fostered by the sun and rain and wind, why should India run after catching nitrogen from the atmosphere by elaborate installation of dead machinery? The living machinery under the

patronage of the sun can supply all the manurial needs better and cheaper than any artificial manure-factory can ever hope to produce.

In fact, all plants are potential nitrogenous manures. When plants and bushes are burnt for fuel, the nitrogen which the sun fixed in the leaf and bark for rejuvenating the soil is returned back to the atmosphere unused. This wastage has to be stopped and all plant material and products are to be returned to the earth after making them ready for absorption by composting with cattle-dung and cattle-urine.

By the use of mechanical tractor and by the use of artificial manures, an animal-less cultivation can be conducted to profit for some time. But if the matter is considered as a whole, if the loss of soil-fertility and the cost of its re-establishment is taken into account, the profit will vanish. Agriculture is a step to nation-building, and when agriculture is conducted with a view to the earning of immediate profits, the agriculturist becomes a bandit.

Misuse of Agricultural Economics

“But economics has done a much greater disservice to agriculture than the collecting of useless data. Farming has come to be looked at as if it were a factory. Agriculture is regarded as a commercial enterprise; far too much emphasis has been laid on profit. But the purpose of agriculture is quite different from that of a factory. It has to provide food that a race may flourish and persist.”

“.....In allowing science to be used to wring the last ounce from the soil by new varieties of crops, cheaper and more stimulating manures, deeper and more thorough cultivating machines, hens which lay themselves to death, and cows which perish in an ocean of milk, something more than a want of judgment on the part of the organization is involved. Agricultural research has been misused to make the farmer not a better producer of food but a more expert bandit. He has been taught how to profiteer at the expense of posterity.”—(P. 198-99)

The Indian economists and scientific advisers, our professors of chemistry and physics in theoretical spheres, advising the nation on agricultural methods, on the establishment of artificial manure-factories, and on the use of artificial manures, should take note of this warning of a British scientist who has spent his life in India and who is now stirring himself in awakening England, America and the rest of the scientific world to the dangers of modernism in agriculture, in plant and animal husbandry.

We, here in India, cannot sit complacently. We have much to do to make useful our useless cattle, to revitalise our soil and give life to our gravel. We have been making no use of human excreta, urine and faeces ; we are burning our cow-dung and not utilising cattle-urine which practically runs to waste. We have to conserve these. Cow-dung will continue to be burnt till the peasant is shown the way how to avoid it. But about human excreta.

and cattle-urine, there is no excuse. Their waste can be materially minimised.

The value of composting

We have known the value of composting. One measure of cattle-excreta can convert 5 or 10 measures of plant-refuse into compost which is superior to cow-dung in manurial value. We have known that cattle-urine is as valuable as cattle-dung. Fifty years ago Dr. Voelcker pointed this out to us. In recent American experience the same knowledge is confirmed and repeated.

Eckles in his "Dairy Cattle and Milk Production" (P. 481) shows that a 1,000-lbs cow excretes 8,000 lbs of urine and 18,000 lbs of dung in a year. The manurial value of 8,000 lbs of urine is \$ 13·60, whereas the value of 18,000 lbs of dung is \$ 13·10. He writes :

"It is a fact often lost sight of in practice that the urine of animals contains by far the most valuable fertilizing constituents of the excreta. That point is brought about by the figures given above where it is shown that 8,000 pounds of urine excreted contain practically the same amount of nitrogen as the 18,000 lbs of dung. One ton liquid cow-manure has a total value of \$ 3·65 or \$ 1·45 more than a ton of cow-dung. These figures emphasise the necessity of preventing the loss of the valuable part of the excrements."—(P. 481)

If, for circumstances over which the peasant has no control, he has to use cow-dung partly or

wholly as fuel, the urine can be saved and fully utilised even at the present moment. Then again we now know that composting is much superior to dunging a field. That compost we can make out of any blessed thing coming out of the earth or from any refuse. If we make the best use of all human excreta and urine, if we utilise the cattle-urine fully and utilise these for making composts, we shall be very largely manuring the soil. The soil, fed by composts, will give us better yields and more nutritious food. Better yields will go to supply greater quantities of fodders for our cattle. They will have more to eat, they will make up their deficiencies, and eat yet more and give more excreta. These again will produce more and richer plants. Ultimately, where there is no acreage under fodder now, some acreage will be available. Once this process is begun, at every turn of the cycle better and better results will be obtained.

Plants will be healthier and bear more fruit ; men and cattle will be healthier and stronger by being maintained on better food, and the soil will be happier and healthier by getting more and more composts. The "mischievous cycle" enunciated by the Royal Commission and talked about by all prior and subsequent economists and authors will change into a magic cycle of health and happiness. Cows will give more milk and this will contribute towards making the human population happier and stronger and disease-resistant. All-round bliss will shower on us. When we have been able to feed a little better our

so-called useless cattle population, we may shift even at the beginning of the process some of them to our gravel and *usar* soils and start making Marienhohes there. All these and more are possible. In fact, there need be no tone of pessimism and no wild and unhealthy talk about artificial manures, artificial birth controls, and slaughter of those animals which are real mothers of prosperity. Even in their apparent uselessness, the so-called useless cattle will be economically useful if we know how to make compost out of their urine and dung and utilise these manures fully in the fields for better crop production. The cow will pay for her maintenance through the increased output of compost made from her dung and urine and cease to be a burden, and to stand as a wall before our economists and scientific men. Then, when the useless animals are made useful in disregard of the exhortations of scientists and economists to slaughter them, and as these begin to pay their way, other very many blissful things will follow, if we stick to those sound, basic principles that helped to keep India alive inspite of our intelligent men themselves following and calling upon others to follow the lead of a dying, hungry, self-centred, monstrous machine-civilisation.

Side-light on the newer knowledge of soil, plant and animal husbandry

We left Sir Albert Howard at Pusa where he had tried experimentally the lessons learnt from his unlettered professors—the peasants and insect pests. He put the new knowledge to use. Side by side

with modernised agriculture at Pusa, the rejuvenated but basically ancient plant and animal husbandry experiments began to be conducted by him. He soon proved that the pests cease to trouble as soon as soil-health is returned by the discontinuance of artificial manures. He proved that artificial manures and plant and soil diseases go together.

Like the Marien-hohe people, but nearly a score of years previous to the Marien-hohe experiment, Howard had got 6 pairs of bullocks to do his plot of farming. The animals were fed on the produce of his farm which were more healthful than the produce of the artificially-manured farm. His bullocks responded to the new treatment. So much so that they became resistant to infective diseases to a large extent. The usual Pusa farm animals were kept in a shed and Howard's animals were separated from them by a hedge. The former developed foot-and-mouth disease; and though Howard's bullocks were separated from them only by a hedge, and though these animals rubbed their noses against the noses of the affected animals, they remained wonderfully immune. Their healthy food and consequent robust health protected them.

Howard's work in Indore

After the Pusa experiments, the field of Howard's work was shifted to Indore where experiments on cotton cultivation were conducted at the instance of the Central Cotton Committee. He tried the use of compost here for prevention of disease, or for the

development of disease-resisting capacity. Compost which had *humas* (vegetable mould) as its ultimate component not only improved the disease-resisting quality but also improved the crops. From Indore the method of making composts and of manuring the crops with them gradually spread to plantations in and outside India.

In 1931 on reading an article entitled "The waste-products of Agriculture," Mrs. Kerr was moved to make experiments on rice. Her place was a Leper Home in the Nizam's dominions. The fields received in Plot No. (1) 2·5 to 1·5 inches of compost ploughed in; Plot No. (2) some rubbish and 0·5 inch of compost ploughed in; and Plot No. (3) received nothing. All the Plots 1, 2, 3, were equal in area, being 6,364 square feet and all received the same measure—6 lbs of seed. The yields were as under :

	Paddy	Straw
No. 1 Plot.	422 lbs.	138 bundles
No. 2 ,,	236 ,,	106 ,,
No. 3 ,,	60 ,,	40 ,,

In other words, No. 1 Plot gave 7 times the yield of paddy and $3\frac{1}{2}$ times the yield of straw as against Plot No. 3. Success followed the use of compost by the Indore process in various fields and plantations. Now, it is no more an experimental affair.

In England a movement to improve the health of the inhabitants of the village Cheshire was being carried on recently, the basis of which was a recommendation to the inhabitants to use health-

giving food. Wheat raised on plots manured by composts was to be the principal cereal. The movement is spreading.

The Indore Process

The name of Indore is connected with the process because it was first tried out there. The process is simple. It needs collection of all vegetable wastes from fields, plants and rubbish heap, and their treatment with cattle-dung and urine in presence of sufficient moisture and with a good deal of aeration. This does the trick. The compost, made according to the process described later on, is a much superior article to cow-dung manure. By the introduction of this process not only the quantity of available manure is very much increased but the product becomes superior to cow-dung as applied usually.

This simple measure is likely to increase the yield of cereals, beans, and grasses. What a potential capacity of the yields of cultivated area opens up before us in the use of the compost ! By the adoption of this method of manuring the pressure on the soil will be significantly reduced ; more area will be left free to come under fodder crops, giving unbounded health to the emaciated and famished cows. There is a chronic want of food for 40 millions of "average men" in India as calculated by Dr. Radha Kamal Mukerjee. This want will disappear and the insoluble problem of feeding the surplus cattle or the entire cattle population will be solved.

Other measures of improvement

Of course, no single thing can accomplish all that we want to achieve. Conservation of human excreta and urine, conservation of animal waste and bone-meal, conservation of all rotting and rotatable vegetable matter, proper cultivation, aeration of the soil, greater cropping of leguminous crops, and less hunger for running after money-crops like cotton or sugar or jute to the extreme limits which get over-produced, the prevention of the export of oil-seeds and oil-cakes and their conservation and utilisation for oil pressing and then for cattle-feeding and manure, the attention to tree fodders, the use of bone-meal as cattle feed—all these and more will be necessary to be done. And to bring this about vigorous healthy village organisations or *Panchayats* have to spring up.

These items are all difficult pieces of constructive work. Difficult though they are, they point a way out of the morass of despondence which the Royal Commission and the long line of economists and scientists have prepared for us. The cry was for the slaughter of cows and limitation of birth; and both being beyond the range of any near possibility, there was no hope either for cattle or for men in India.

The discussions in Part II—"How to save the Cow"—and in Part IV on "The Dairy Industries"—open up possibilities of improvement of cattle and of economic salvation without having to take recourse to the slaughtering of cattle and to the use of contraceptives for men. We may now proceed,

confirmed in the belief that the cattle in India can be saved and that there is a chance of improvement for both the cattle and the dairy industries.

Mixed farming in India

In this country there is no dairy industry proper except in a few towns. And this is natural and is as it should be. Pure dairying or keeping the cattle exclusively for milk production is a novelty of the West where the cow functions only to supply milk and meat. The cow is kept so long as she will give a satisfactory quantity of milk, and after a certain age when milk is likely to fall, she is slaughtered for meat. Rarely do cows pass the age of eight years. In these eight years she gives four or five calves, and her milk-yield is naturally on the decline afterwards. To make dairying pay its way, she is fattened and handed over to the butcher at the prospect of the fall of her milk-yield. The calves are reared only to the extent of keeping up the supply of dairy cows. The excess is handed over to the breeders for veal and meat from whom they find their way to the butcher. Of the males, only those that are required as sire-studs are reared, and all the rest of the male calves are fattened and slaughtered. The Dairy Industry is a side-line to slaughtering or the beef industry. And it is for this very reason that persons familiar with the Western methods get impatient with the Indian practices, and again and again the so-called ignorant peasant is held up for castigation for not doing what his Western

opposite number does, i, e, breed cattle for slaughter, keeping milking only as a stage in the process.

In Europe they have no use for the bullock and, therefore, what they do serves their particular need of the moment. But it is doubtful, extremely doubtful, if they will be able to continue for long their present practice of cow-rearing for slaughter. It is beginning to dawn upon their wise men that artificial manure is no substitute for cattle-manure. The time may come when to meet the need of the supply of cereals and grains, they may have to manure their fields with cattle-manure. The cow will have to function then for the supply of manure. That time may come early or late depending upon many political factors, factors of exploitation, of war and of annexations and of mandates. Changes in these directions may force the cow in those congested European countries to function as the supplier of manure earlier than we can think of today.

Milker and manure producer

Whatever happens to Europe, our immediate concern is with India, and one has to be particularly on guard to see that the importance of the cow as the mother of the bullock and as the producer of manure is not minimised. Already mischief has seriously begun in advertising the she-buffalo as the milch-animal in preference to the cow. The she-buffalo is an usurper and is cutting the ground from below the feet of the cow by the short-sighted policy of conducting dairying for profit unconnected with real economic

welfare and unconnected with the real value of her milk assessed on its total nutritional content.

The cow is the mother of the bullock and, therefore, she has to be maintained to keep up the supply of bullock-power for the land. She is a milker also and provides us with the most nutritious food available to man. Dairy industry proper in the European sense is a misfit. In India the cow has to be maintained both for the bullock and for the milk. This means keeping the cow for the dual purpose of cattle-farming and dairy-farming. To these two functions is joined the most indispensable function of supplying manure, and it is from this direction that it would not be surprising to see a change quickly coming over in Europe, shorn of its colonial possessions. If Europe is to grow her own food then it may not pay to slaughter cows. On the contrary, it may be obligatory to stop cow-slaughter for obtaining her manure. But out here in India, those who are advocating the establishment of the dairy industry after the Western pattern are definitely misleading. The cow is the husbandman's animal in India. She will continue to procreate for cultivation principally, and she will be functioning to supply the equally important article of diet, her milk.

The Cattle versus Goat !

Fragmentary thinking may spoil the future, as it has begun to do in more than one direction. Milk has already come to be looked upon as an isolated item.

of commerce. To obtain milk anyhow, and cheap milk at that, is the objective. The recent publication of the Government Marketing officer is an instance of this. In his book—"The Marketing of Milk—" the author is seriously advocating the keeping of goats as the milking-animal, the reason being that some goats give milk which may equal in quantity to the milk of some wretched cows. To this Department of the Government—the Marketing Department, marketing is every thing, and whether the Marketing Department's proposals cut across national welfare is no concern of the Department. According to it, goats are to be preferred to the cow for milking. Already there is the Government-encouraged movement for pitting the buffalo as the milch-animal. And now this new Department of Marketing is proposing to pit the goat also against the cow for milking. Will the goat also give us bullocks for carrying on cultivation? The goat with its pair of close-set teeth protruding out on the muzzle can cut grass in the pastures to the very root. Pastures over which the goat has passed grazing are no good to the cow. Before the grass attains the size suitable for being grazed upon by the cow, the goat forestalls her and makes the pasture unfit for the cow. Yet, there is this absurd recommendation for rearing goats for milk.

"Goats of certain breeds give as much milk as some of the cows, while their initial cost is comparatively small. The Provincial Animal Husbandry Departments should, therefore, pay greater attention to the improvement of goat breeds

and to their introduction in suitable areas.”—
(Report on Marketing of Milk. 1942, P. 285.)

There is no expression of apprehension at all of hurting the cow by the emphasis put on goats. No thought is given to the fact that the cows will be suffering if more goats are bred with them, and ultimately the main supply of draught-power for India will suffer. There may be immediate gain to the goat-milk producer. Observations and recommendations like these come out of fragmental consideration of problems of national importance. This spirit pervades almost all Government departments.

Railways cut across the country and throw embankments obstructing the natural drainage, and ruining the agriculture of miles after miles of land. But who cares and who considers? The Railway Board wants to construct permanent ways at the cheapest cost and if their plans cut across the greater interest of the population, it is no concern of the Railway Board. If their immediate profit motive is served, no other consideration is allowed to stand in the way. The same is the tale about canalisation and irrigation; and the same about plantations too.

Need for all-embracing thought

Thinkers and patriots should have width of outlook to judge a scheme from the general utility view. Short-sighted fragmental considerations are overcome when the oneness of interests in all social, political and industrial matters are realised.

I have discussed in some detail the oneness of the problem of the soil, plant, animal and man. When all the four are considered as one, the proper perspective is obtained. The same applies to animal husbandry and the dairy industries. If we detach them we step towards failure ; if we consider them as one we take the right line. This right line has to be taken. Dairying has no place without a consideration of animal husbandry, animal health, and soil health in general.

Cattle industry, agriculture, the dairy industry, are all phases of one and the same industry with the cow at the centre.

The cow-centred India

We shall, therefore, look upon the cow not as a bullock-supplier, nor as a giver of milk or a dairy animal, nor as a supplier of manure, but shall regard her as a combination of all these in one. Consideration of none of her three functions need be made secondary. When we speak of the cow as the mother of the bullock we need not and should not minimise her importance as a dairy animal and as a manure-giving animal. Similarly, in dealing with the cow as a dairy animal, we must not regard her other two functions, procreation, of the bullock and manure production, as of secondary importance, As for the consideration of the cow as a manure-giving animal, the importance of it is just beginning to be understood. As a manure-giver her function is hardly of less importance than her functions as the

mother of the bullock and as a dairy animal. She is the supreme animal before us supplying bullocks for tillage and for traction, supplying manure for the growing of crops, and supplying milk for human subsistence. She is valuable and dear to us on all these three counts and more. She stands before us to take our adoration as an emblem of the whole animal world in relation to man. This aspect is of no less importance than her purely economic aspect. This superior aspect of relationship has put her on a higher plane before us. She is more than a mere animal to us. She is an expression, in form, of the higher aspiration within us for unification with all living things. She has to be loved, nursed and to be well taken care of. India is one large agricultural farm, inhabited by Indian farmers. The cow is at the centre of this big farm-house. Cow-keeping-cum-agriculture is the one great industry of India. Nothing else can take its place. When the cow is allowed to thrive and multiply, men will also thrive. If the cow is neglected, if the cow is slaughtered, ruin and devastation will be the feature of India as is the case now. The cow properly placed, treated and loved, will allow India to come to her own. In developing the lost respect for her life and welfare, respect for all life and the welfare for all will follow ; and a healthy social atmosphere will develop. Misery and slavery that characterise India today will disappear from a cow-centred India.

The Cow In India

VOL. I

PART-I

BREEDS, BREEDING AND ECONOMICS

PART—I

BREEDS, BREEDING AND ECONOMICS

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CHAPTER I

THE INDIAN COW

1. Ancient knowledge of veterinary science : The cow has been an object of special care and affection in India from the earliest times. Our mental attitude towards the cow as representing all animal life has shaped the civilisation of India. The cow has been the wealth of the wealthy in India for many centuries past. Yet it is strange that in spite all these, not much ancient literature on the cow is available—its anatomy, its up-keep, and its diseases and cures.

Recently Mrs. Leslie H. Shirlaw took pains to summarise the bibliography of our ancient books on the veterinary science and practice. While some very interesting and important books have been catalogued by her on horse-keeping, very little of serious importance has been discovered about the literature on cow-keeping. What has been brought out is, however, a milestone on the way to the enquiry about the ancient literature on cow-keeping. *

2. The temple and altar : There was undoubtedly a knowledge of the anatomy of the animals. To the early veterinarians the temple acted as “the anatomical

* A short History of Ayurvedic Veterinary Literature, by Leslie Hamilton Shirlaw. *Journal of the Veterinary Science and Animal Husbandry*. Vol. X. Part I.

laboratory and the altar as the *post-mortem* table." But this was not all. Before the days of the Buddha, teachers used to lecture on comparative anatomy to their students on occasions of animal sacrifice, and the students to practice evacuation on the urinary organs of the dead animals, scarification of their hides, venisection on their vessels and extraction by the removing of their teeth. It was possible thereby to acquire a basic knowledge of surgery.

3. Veterinary science and military transport : During the post-Vedic period Sanskrit literature is full of references to the veterinary science. The needs of the army naturally created special interest in the horse, the elephant and the bullock, as constituting the two arms—the fighting and the transport arms of the forces. Veterinary science was included in the curriculum of the medical schools of the time. In the *Arthasastra* of Kautilya, reference is made to the highly organized state of the Live-Stock Department. What Chandra-Gupta Maurya did for his veterinary department, the present Government in India is still trying to do. In fact, the best-organised dairies and remount departments of today belong to the Government of India military departments. The Emperor Asoka carried the advancement further by the establishment of hospitals for men and animals all over his empire.

In *Sukraniti* of the 9th century mention is made of superintendents of State departments for each variety of domestic animals under each of whom a specially qualified veterinary officer was appointed.

4. **Salihotra and his works** : Of all the authors on veterinary science the name of *Salihotra* stands out bright and still shining. After him veterinary science came to be known by his name—Saluteri of the Greeks, and the veterinarian was the Saluter. Salihotra appears to be the name of a village near Taxila from which our famous author took his name.

Salihotra taught the history, training, feeding, stabling and grooming of the horse, and also how to treat a horse in health and disease. The best-known manuscript of Salihotra is preserved in the India Office Library.

In 1788, Earles, an Englishman, published a treatise on horses—"Saloter or a complete system of Indian Farriery, in two parts". The manuscript of this translation is preserved in the British Museum.

There are other editions of 'Saluter' extant. The latest one is a Bengalee book by Nidhiram Mukherjee—"Salihotra Sara-Sangraha"—in which the author appears to have derived his materials from Salihotra and other books. The next best-known veterinarian is Jayadutta Suri who also wrote on horses. The title of his book is "Asva Vaidyakam". This book may have been written about the 14th or 15th century A.D.

Similarly, several well-known books can be traced to their authors on elephants, but very little has been left of the written knowledge of the ancients on cow-keeping. May be, this subject was developed by persons who propagated the art and science through their own sects in different parts of India, and no celebrated personality arose to put down in writing

all that was known and practised. It cannot be that while veterinary knowledge on horse and elephants had flourished, such an important animal as the cow was neglected. The only written material available today is the reference to cattle medicine in Sanskrit literature and in the *Puranas* and *Samhitas*.

5. Veterinary science in Purana and Samhita : The *Agni Purana* contains sections on cattle diseases. In the *Krishhi Sangraha* specific rules are given regarding the construction and sanitation of cow stalls, the keeping and employment of cattle, and there is a description of the diseases and treatment of cattle.

The *Parasar* and the *Atri Samhitas* detail the proper uses to which the cattle should be put. The *Sukraniti* gives rules for ascertaining the age of bulls from their teeth. The *Matsya Purana* describes the proper type of bulls for "Brishotsarga"—a part of the *Sradh* ceremony performed by Hindus on the death of their parents.

6. Veterinary practice found in Ain-i-Akbari : The following from the *Ain-i-Akbari* gives us a picture of how the cow fared during the times when Muslim kings ruled in Delhi.

"Throughout the happy regions of Hindusthan, the cow is considered auspicious, and held in great veneration ; for, by means of this animal, tillage is carried on, the sustenance of life is rendered possible, and the table of the inhabitant is filled with milk, butter-milk, and butter. It is capable of carrying burdens and drawing wheeled carriages,

and thus becomes an excellent assistant for the three branches of the government.

"Though every part of the empire produces cattle of various kinds, those of Gujarat are the best. Sometimes a pair of them are sold at 100 muhurs. They will travel 80 kos (120 miles) in 24 hours, and surpass even swift horses. Nor do they dung whilst running. The usual price is 20 and 10 muhurs. Good cattle are also found in Bengal and the Dakhin. They kneel down at the time of being loaded. The cows give upwards of half a *man* of milk.

"In the province of Dihli again, cows are not worth more than 10 Rupees. His Majesty once brought a pair of cows for two lacs of *dams* (5,000 Rupees).

"In the neighbourhood of Thibet and Kashmir, the *Qutas*, or Thibetan Yak, occurs, an animal of extraordinary appearance.

"A cow will live to the age of twenty-five.

"From his knowledge of the wonderful properties of the cow, His Majesty, who notices everything which is of value, pays much attention to the improvement of cattle. He divided them into classes, and committed each to the charge of a merciful keeper. One hundred choice cattle were selected as *Khasa* and called *kotal*. They are kept in readiness for any service, and forty of them are taken unladen on hunting expeditions, Fifty-one others nearly as good are called half-*kotal*, and fifty-one more, quarter-*kotal*. Any deficiency in the first class is made up from the second, and

that of the middle from the third. But these three form the cow stables for His Majesty's use.

"Besides, sections of cattle have been formed, each varying in number from 50 to 100, and committed to the charge of honest keepers.

"The rank of each animal is fixed at the time of the public muster, when each gets its proper place among sections of equal rank. A similar proceeding is adopted for each section, when selected for drawing waggons and travelling carriages, or for fetching water (*Vide Ain* 22).

"There is also a species of oxen, called *gainsi*, small like *gut* horses, but very beautiful.

"Milch-cows and buffaloes have also been divided into sections, and handed over to intelligent servants."

"*THE DAILY ALLOWANCE OF FOOD*: Every head of the first *khasa* class is allowed daily 5½ s. of grain, ¹ and 1½ d. of grass. The whole stable gets daily *I man* 19 s. of molasses, which is distributed by the *Darogha*, who must be a man suitable for such a duty, and office. Cattle of the remaining *khasa* classes get daily 6 s. of grain, and grass as before, but no molasses ² are given.

"In other cow-stables the daily allowance is as follows. First kind, 6 s. of grain, 1½ d. of grass at court, and otherwise only 1 d. The second kind get 5 s. of grain, and grass as usual. The oxen used

1. Dana gram, see p. 142. note 1.-P.—*Ain-i-Akbari*.

2. Qand-i-siyah, see p. 142, footnote 8. P. probaly gur.—*Ain-i-Akbari*.

for travelling carriages get 6 s. of grain, and grass as usual. First class *gainis* get 3 s. of grain and 1 d. of grass at court, otherwise only $\frac{3}{4}$ d. Second class do., $2\frac{1}{2}$ s. of grain, and $\frac{3}{4}$ d. of grass at court, otherwise only $\frac{1}{2}$ d.

"A male buffalo (called *arna*) gets 8 s. of wheat flour boiled, 2 s. of *ghi*, $\frac{1}{2}$ s. of molasses $1\frac{1}{2}$ s. of grain, and 2 d. of grass. The animal, when young, fights astonishingly, and will tear a lion ³ to pieces. When this peculiar strength is gone, it reaches the second stage, and is used for carrying water. It then gets 8 s. of grain, and 2 d. for grass. Female buffaloes used for carrying water get 6 s. of grain, and 2 d. for grass. First class oxen for leopard-waggon⁴ get $6\frac{1}{4}$ s. of grain; and other classes, 5 s. of grain, but the same quantity of grass. Oxen for heavy waggon⁴ got formerly 5 s. of grain, and $1\frac{1}{2}$ d. for grass; but now they get a quarter *ser* less, and grass as before.

"The milch-cows, and buffaloes, when at court, have grain given them in proportion to the quantity of milk they give. A herd of cows and buffaloes is called *that*. A cow will give daily from 1 to 15 s. of milk; a buffalo from 2 to 30 s. The buffaloes of the Panjab are the best in this respect. As soon as the quantity of milk given by each cow has been ascertained, there are demanded two *dam*s weight of *ghi* for every *ser* of milk."

3. Sher in India is the tiger, but shir in Persia is the lion.

4. Carriages for the transport of trained hunting leopards. Vide Book 11, Ain 27.—Ain-i-Akbari.

Things which could give us today an accurate idea as regards the care and management of the cow, their feeds, their diseases and their treatment, their breeding and the best breeding tracts and types as these were in pre-British times, are not available in any of the several manuscripts or printed matter. But the knowledge exists. There are still castes of breeders in India who know their job and are able to present the modern veterinarian with their store of accumulated knowledge of the past. While much is being done to modernise the veterinary department in India, while valuable researches are being conducted for stamping out cattle disease and for finding the nutritive value of Indian grasses, while attempts are being made to preserve the distinct types of breeds still existing in India—while all these very valuable and urgent works are being done—it is at the same time necessary to find out the really qualified and experienced men from amongst the stock breeders and popularise what is known to them and what is a natural development of ages of experience and study. This would be an improvement from within.

7. The cow and Indian agriculture :— The cow in India is intimately and indissolubly connected with agriculture. She is the mother of the bullock, the supreme and only draft animal of the cultivator. Without the bullock there would be no cultivation, without them country roads would be destitute of the one vehicle of land transport—the bullock cart. Apart from the religious veneration in which the

cow is held in India. it is a fact that she is the animal on whom the well-being and normal life of India depends. The cow and agriculture being thus connected together, where there is good agriculture the cow is also good ; for, without efficient cows or which is the same thing without efficient bullocks, efficient agriculture is impossible.

Western thoughts and education have got such a hold on the minds of our educated men that often we are led to belittle what is really our strength. That Indian cows are inferior and Indian agriculture is primitive, that the Indian agriculturist is ignorant, lazy and without initiative—these and such other hundred things we have taken as axiomatic truths. When going through the subject of animal husbandry and dairying, one painfully comes across too many Indian authors who have unreasonably condemned Indian methods and heaped condemnatory epithets on Indian peasants, which are as remarkable for ignorance as for contemptuous harshness.

8. **Dr. Voelcker's report on agriculture 1890 :** Indian agriculture with which may have been bracketed Indian animal husbandry are not to be dismissed with a derisive smile. It is the unhappy lot of India in her state of political subjection to have to depend on British experts for matters of opinion on agriculture or dairying. It is seldom that we find men of science, without prejudice and without imperialistic purpose behind, come out to India to learn and study and appreciate and give opinion on matters that vitally affect Indian interests.

In the whole range of agricultural literature created under the auspices of the British Government in India, two names stand out prominently. One is of John Augustus Voelcker PH.D., B.A. B.Sc., F.I.C., etc., consulting chemist to the Royal Agricultural Society of England. He came to India on an agricultural mission in 1890. The other is of Norman C. Wright M.A., D.Sc., PH.D. Director, Hannah Dairy Research Institute, Ayreshire (Scotland), who came to India in 1937 on a similar mission, to report on the development of the Cattle and the Dairy Industry of India. Wright's special contribution is to the Dairy Industry.

Doctor Voelcker was to 'report on the improvement of Indian Agriculture'. He was an agricultural chemist and the services of an agricultural chemist was specially sought to make helpful recommendations so that by the improvement of agriculture, the recurring famines of India could be stopped. His commission was really a remote outcome of the Famine Commission of 1837 to implement its recommendations.

Dr. Voelcker came as a scientific enquirer. In his opinion: "the attitude one ought to adopt in coming to a land full of novel conditions is that of a learner, and not of the adviser or the critic; it is only when one has learnt something of the peculiar surroundings of his subject that he should attempt to suggest anything, and this he will, if wise, do very cautiously, feeling how very much there is for him still to learn, how much that he

will never be able to learn." (P. 12) Dr. Voelcker toured over and stayed in India for thirteen months before he drew up his report—a report replete with scientific spirit and rare knowledge which will stand as a land-mark of understanding of Indian agriculture and animal husbandry of the present times.

We shall look with Dr. Voelcker's eyes on Indian agriculture to understand both the agriculture and the cow in India. Regarding Indian agriculture Dr. Voelcker wrote in his report ;

"It is a much easier task to propose improvements in English agriculture than to make really valuable suggestions for that of India, such suggestions, I mean, as have a reasonable chance of being carried out. Altogether the condition of the cultivating classes, the peculiar circumstances under which husbandry is carried on, the relations of the State to the people and many other factors, have to be taken into careful consideration before one can give an opinion, and even that opinion must be given in very guarded terms. As India is not covered by one people but by a number of different and diverse peoples, so it may be said of the agriculture and its systems as practised in different parts. That it not only needs, but will repay close and careful study, I am convinced ; and until systematic enquiry be made, not in a hurried way in which the exigencies of the case have obliged me to pursue my enquiries, but by patient watching and learning, no really sound knowledge will be

obtained, nor any great improvement be intelligently inaugurated.”—(P. 10)

9. Indian agriculture not primitive or backward : “On one point there can be no question, viz, that the ideas generally entertained in England, and often given expression to even in India, that Indian agriculture is, as a whole, primitive and backward, and that little has been done to try and remedy it, are altogether erroneous. It is true, as indicated above, that no matter what statement be made, as deduced* from the agriculture of one part, it may be directly contradicted by a reference to the practice of another part, yet the conviction has forced itself upon me that, taking conditions under which Indian crops are grown, they are wonderfully good. At his best the Indian *raiya*t or cultivator is quite as good as, and, in some respects, the superior of the average British farmer, whilst at his worst it can only be said that this state is brought about largely by an absence of facilities for improvement which is probably unequalled in any other country, and that the *raiya*t will struggle on patiently and uncomplainingly in the face of difficulties in a way that no one else would.”—(P.P. 10-11)

“Nor need our British farmers be surprised at what I say, for it must be remembered that the natives of India were cultivators of centuries before we in England were. It is not likely, therefore, that their practice should be capable of much improvement. What does, however, prevent them

from growing larger crops is the limited facilities to which they have access, such as the supply of water and manure.—(P. 11)

A PERFECT PICTURE: “But, to take the ordinary acts of husbandry, nowhere would one find better instances of keeping land scrupulously clean from weeds, of ingenuity in device of water-raising appliances, of knowledge of soils and their capabilities, as well as the exact time to sow and to reap as one would in Indian agriculture, and this not at its best alone, but at its ordinary level. It is wonderful too how much is known of rotation, the system of ‘mixed crops’ and of fallowing. Certain it is that I at least have never seen a more perfect picture of careful cultivation combined with hard labour and perseverance and fertility of resource than I have seen at many of the halting places in my tour. Such are the gardens of Mahim, the fields of Nadiad (the centre of the ‘garden’ of Gujarat, in Bombay) and many others.”—(*Ibid.*)

Dr. Voelcker does not confine his eulogy only to the excellence of the cultivator and cultivation. When he comes to consider the manuring system, the agricultural implements and the watering appliances, he is equally full of praise as will be found from the following paragraph.

10. **Machines and cultivators’ implements**: “It may be said generally as regards machines that where speed is not required, *cattle power* will always beat steam power in India.—(P. 224)

"Any one who has watched the clever devices of the native cultivators in the *implements* which they use for harrowing, levelling, drilling, raising water etc., will see that if anything is to replace the existing implements it must be simple, cheap and effective. He will, indeed, be a clever man who introduces something really practical. I was specially struck with the effectiveness of a small hand-pick in common use for digging holes to put seedlings into. Another useful implement is the *kodali* or *hoe*; I have heard indigo planters say that, if they could afford it they would prefer to have their fields broken up with this hoe rather than with any kind of plough. The native raises the *kodali* above his head and brings it down with force into the soil. It penetrates about 4 inches and brings up the soil in large blocks which are left to weather down. Dub-grass can be exterminated in this way."—(P. 224-'25)

"After seeing for myself what is used, and what have been suggested for use, I am obliged to conclude that there is not much scope for improved implements under existing conditions".—(P. 217)

The *Indian plough* used to be pooh-poohed. But Dr. Voelcker finds in it an efficient instrument and opines that deep ploughing as against the so-called scratching by the Indian plough would spoil the soil by allowing the subsoil water to evaporate, whereas the country plough conserves the moisture in the soil.

Dr. Voelcker's observations clearly show that there is knowledge and *efficiency* underlying the *agricultural methods* in India. Of course, these methods are in some instances capable of improvement, and Dr. Voelcker made suggestions, which, if really given effect to by the Government of India, would have wholly changed the agricultural outlook of India and would have brought in mass prosperity to a very large extent. Instead of doing the very necessary things urged by Dr. Voelcker, the Government went on in its own way and brought into being another Royal Commission (1927) a generation afterwards, a commission of negation except for the organisation of some Imperial Agricultural and Research Services.

Dr. Voelcker had referred to the excellent state of agriculture of those times. The latest Agricultural Commission brought out how efficient were the methods of cattle-breeding in India that have preserved some of the types of cattle even in these days of ignorance and neglect.

11. **Efficient breeding methods of India :** The Royal Commission on Agriculture touched on this subject in their report :

"If enquiry were to be made into the history of such breeds as the Ponwar of the U.P., the Hariana and Sahiwal of the Punjab, the Tharparkar and Sindhi (Karachi) of Sindh, the Malvi of Central India, the Kankrej of Gujarat, the Gir of Kathiwar, the Gaolao of the Central Provinces, and the Ongole of Madras, we believe it would be found, in most cases, that their excellence is due to the care

bestowed on them by the professional cattle breeders, usually nomadic, who were formerly common in India, but who are now abandoning grazing as the result of spread of cultivation. Many references to these herdsmen and to the part they took in supplying cattle to cultivators will be found in Gazetteers describing former conditions in India. In some localities their disappearance has been welcomed, for they frequently combined the profession of crop raiding with that of cattle rearing ; but in districts in which they adhered to their legitimate business, their loss is to be deplored. They were the only members of the rural population who paid attention to breeding, and understood the management of cattle ; they usually worked under unfavourable conditions, but their skill in selection and tending cattle was so considerable that they were able to show good herds."—(P. 199)

After Lord Linlithgow became Viceroy, a distinct drive was given to preserve the well-known breeds of the cow in India and generally to improve cattle-breeding. It was estimated at the time of the Agricultural Commission (of which Lord Linlithgow was the President) that 2 lacs of bulls were necessary every year for breeding all over India in order to make an effective start for the improvement and for the grading up of the neglected breeds. But where were the 200,000 bulls every year to come from ? They did not exist. In a country where there are 150 to 200 million heads of cattle, it

is estimated that one million good bulls are needed at least at any one time as against the statistical figure of the existing 5 million bulls, mostly *scrub*. When these 1 million good bulls are supplied then a steady supply of two lacs new bulls every year have to be kept up. In an attempt to supply bulls in the Government farms which had taken up cattle breeding, there could during the three years 1923 to 1926 be supplied only 519 bulls. The largest supply, 320 bulls, went to the Punjab against its estimated necessity of 10,000 bulls per year.

Why has this condition come about and how has it happened? The story has not been fully told anywhere. There are, however, plenty of materials for forming an idea of how it came about. (144, 175, 187, 369-'71)

12. State aid for improvements in the past : Agricultural methods in India are of an improved type. The agricultural instruments are also suitable for the purpose for which they are intended. Agricultural methods and the implements depend absolutely upon the capacity and will of the agriculturist. But in such a matter as animal husbandry individual efforts are not as important as in agriculture. The State has to come in. And the State did come in the old days to fulfil its proper function. The great irrigation works are instances. Without water, cultivation of superior type is hardly possible. To meet the needs of cultivation large irrigation works were accomplished through all the ages. Invaders had come and left India and occasionally perpetrated

cruel acts of vandalism in destroying irrigation works. But still the urge on the part of the State to provide for irrigation continued to operate. The irrigation canals, the embankments, the dams and the large tanks distributed all over India show how the governing authorities discharged their duty in this direction. There is no system of irrigation equally applicable to all parts of India. The best and most suitable forms were selected for particular localities and the plans executed almost to perfection. I am not referring to the early days of Aryan rule. Later, during the short Moghul period, just when things were settling down to ordered administration, we find excellent irrigation schemes undertaken and executed. The present *Jamna canals* of the British period are only extensions of the work of the past rulers.

As population increased more land had to be brought under the plough and, therefore, more provision had to be made for water. Large tanks continued to be excavated all over India wherever they were needed for irrigation purposes.

When British rule came, the new rulers were imbued with a superiority complex, and they succeeded in transplanting an inferiority complex in the minds of the subject people. Then began an all-round deterioration in our individual and corporate life. What the Britishers did not understand was to them of no worth, and the men of Indian birth who were elevated to high positions by the new rulers also said so and believed that it was so.

13. **Modern education dissociates men from village life :** Agriculture, irrigation, canalisation and cattle-breeding were not the subjects that vitally interested the early British administrators. They wanted loyalty, they wanted peaceful exploitation. All measures were shaped to that end and the final blow was given when education also was shaped to serve that very end. The glamour of English education was catching, and it was taken for granted that what was taught in the English schools and colleges were the subjects worth knowing and caring for. Education became theoretical, and was detached from application to daily life. It drew the attention away from the essentials of life to the creation of hands to fill the places under the Government services ; the whole education machinery was shaped for the creation of that two per cent required for service under the new rulers. Agriculture, irrigation and cattle-breeding were subjects too mundane for the newly educated. They set the tune of social life and conduct. For several generations this has gone on. And it is, therefore, that in an old, highly civilised and densely populated industrial and agricultural country like India, the essential knowledge of life and living fell out of tune with the trend of so-called civilisation introduced by the British rulers.

The village and the villagers were left to their fate. Out of the agriculturists a new class arose, the middle class, which learnt to understand and translate into action what the British masters of India taught and desired. The villagers copied the example

of these men. The cultivators also learnt to desire English education for their children. An education, unnatural, unsuited to the needs of the land and unsympathetic to the welfare of India, sprang up. No wonder that the *cattle breeder* vanished as referred to in the report of the Royal Commission previously quoted. (11) No wonder that the cattle has been deteriorating. The real wonder is that it has not gone deeper down than where it is yet found. For, where is the place of a cattle-breeder in English-educated India?

Kunwar Sir Jagadish Prosad, K.C.S.I., C.I.E., O.B.E., member-in-charge of the Department of Education, Health and Lands of the Viceroy's Executive Council, while opening the third meeting of the Animal Husbandry Wing of the Board of Agriculture and Animal Husbandry in India, held at New Delhi in 1939, pointing out in his opening speech, to the causes that hindered the progress of Animal Husbandry, observed :

"A third cause is that our system of education has hitherto had a marked urban bias. The educated Indian as a class is, therefore, not what I might call animal-minded. He is not sufficiently interested in animal life. He is apt to regard discussions about the improvement of animal breed with amused indifference and often with contempt. He regards such topics, very often, as vulgar and hardly deserving serious attention from those immersed in the subtleties of higher metaphysics and the niceties of literary criticism."

And yet Kunwar Sir Jagadish Prosad, who was in charge of the Department of Education at the time, was easily satisfied. He did not mention how he proposed to change the type of education to make it "animal-minded" or as one might call it—village-minded. He was satisfied that His Excellency the Viceroy had been taking interest in the subject. He went on to say :

"But I am glad to note that a welcome change in outlook is noticeable, and in bringing it about the knowledge and enthusiasm and the example of His Excellency the Viceroy have played a noticeable part. He has done immense service in bringing home to us the dimensions and the importance of the problem of animal husbandry. Most provinces have provincial and district livestock associations. I trust that the impetus to cattle improvement given by His Excellency the Viceroy will abide."

There ought to have been no such illusion. The impetus given by the Viceroy was already nearly spent up by the time this meeting was held, and His Excellency could do little unless the whole outlook was changed through a change of education in India. This is not a new subject—this barrenness and positively *harmful* nature of *education* in India. Even in connection with this very subject of the improvement of agriculture and animal husbandry, we find that as far back as fifty years, Dr. Voelcker clearly put down what was needed in the matter of education. What could not have been done in the fifty years

that have elapsed ? A new people, a new generation of village-minded Indians, could have been created. But that would not have served the purpose ; on the contrary, that would have stopped the very exploitation upon which capitalist imperialism thrives.

14. Dr. Voelcker on education and rural life :
Dr. Voelcker (1890) had observed :

“For myself without a knowledge of the languages and a very limited one of the people, it was much harder to come to a conclusion upon matters connected with Education, more specially that which would meet the *raiyat's* wants, than to form an opinion upon what I could see with my own eyes, such as the practices of agriculture or the conduct of experiments. *Agricultural education*, again, cannot be taken out of its connection with *general education*, and I had neither the time nor the power to acquaint myself with the systems of general education as carried out in different parts of India. My observations upon the various grades of schools where I think that agriculture might enter as a part of the educational scheme may, therefore, not be assigned to their right divisions, or be only of partial and not of general applicability to India as a whole.”—(P. 378-'79)

“There is very little doubt that the tendency of education in the past has been too much in a purely literary direction, and that it has been diverted from, rather than turned towards, the staple industry of the country, viz., agriculture. Agriculture is by far the most general pursuit, and

it is that which contributes the bulk of the Revenue of the country. According to the Census Returns of 1881, 72 per cent of the whole male population engaged in some specific occupation are directly supported by agriculture, and the estimate of the Famine Commissioners was that 90 per cent of the rural population live more or less by the tillage of the soil. Nevertheless, it is found that the tendency of the *education* at the present time is to *draw* the rising generation *away from the land*, and to give a purely literary training which ends in a young man making his aim the obtaining of a post under Government or the following of a profession of a 'Pleader' in the courts. Agriculture is not regarded as a profession but too often as a medium of deriving an income off the land; owners of land do not look to their property themselves but leave it to the care of superintendents, and prefer to make money in the town by trading rather than by agriculture. So it comes about that estates worth a lac of rupees are managed by men on a pay of Rs. 25/- a month; there is no intelligent farming class, nor even a good class of superintendents. The young man after receiving his education is at the end in Government employ; the student at any Agricultural College will rather take Government appointments worth Rs. 50/- a month than devote himself to the management of his farm or superintend that of some one else; and lastly there is a general impression that

every thing pays better and is more dignified than farming.—(P. 379)

“The present system of education is not sufficient to create and maintain that interest in the cultivation of the land, which ought to be taken in an essentially agricultural country, and the only way to effect this is to substitute *Agricultural Education* for a part of the present educational programme. The advantages of such a course would soon be apparent, for, where so large a portion of those who are to be educated are brought up amid rural surroundings, it must be simpler to bring before them objects which are familiar to them in the every-day life than to instruct them in the literature and history of a foreign country totally different to their own. The benefit of a more technical course of education is that it maintains the connection between the teaching which a lad receives and the calling which he is to follow in after-life ; in no branch could this be more important in India than in agriculture. The teaching of the rudiments of science also is far more likely to lead to habits of observation and of desire after enquiry, than a purely literary training. Even in the very simplest form of education the illustration of the lesson by means of the ordinary objects and operations of agriculture is the most ready help, and is more likely than anything else to awaken the interest of the scholar and to bring home the lessons to his comprehension. Object-lessons can nowhere find more apt illustrations.

Then, as we go higher in the scale of education, the same subject is fertile in ideas familiar to the pupil, and then it is that an effort should be made to awaken his interest in the great industry and to impart a knowledge of its principles which may be of use to him in his after-career. Nor need this interfere with a lad's general education in reading, writing etc.; it merely helps his comprehension by bringing before him familiar objects, and gives him later on the opportunity of utilising the knowledge of those elementary principles which he has learnt in his earlier days. When, as I have shown, the problem of agricultural improvement is so great a one, it becomes all the more necessary that early in life a sound teaching should be imparted in the elements of agriculture, so as to enable those whose times will be largely spent in its pursuit to enter it with a fair understanding of its aims and guiding principles."—(P. 380)

This outspoken and sincere opinion of an agricultural chemist came out of the love he bore for agricultural pursuits. He called agriculture a 'career'. But agriculture had ceased to be a career to the millions of India after the transformation wrought in its administration by British habits of thought and conduct.

The object of British administration had not been to develop the resources of India for the Indian. The very basis of education was, therefore, from the beginning of the administration wrongly and ignorantly laid down. Lads were sent to school

not to take up any of the numerous professions of their fore-fathers but simply to get a passport to Government service or to any of the positions, newly opened up in the form of the numerous occupations in courts from pleaders to peons.

An agriculturist in India at the time of Dr. Voelcker (1890) could perhaps earn by his calling just enough to keep body and soul together. Now, at the present time, the new village school opens before its student a vista and a path by which he may range with the exploiters rather than with the exploited like his neighbours. The agriculturist sends his boy to the primary school surely not that the lad might take up agriculture and be of help to him in after-life, and be fitter in harvesting greater crops from the same field and more milk from the same herd. In a free county this would have been so. But not so in India under British rule.

15. Education helping exploitation : Every lad attending a school is a prospective exploiter. He is sent there knowingly or unknowingly for that purpose. That cultivator-father who wanted his son to be a cultivator after having completed his school education must be a rarity. And naturally so. The sum-total of the cultivator's earnings might be 15 rupees per month, whereas his son after having passed the Matric examination would be in for a post in the town which might bring him Rs. 25/-. This young man may spend the whole amount on himself or might by making a saving of say, Rs. 10/- per month, send the saving to his parents till he himself begins to

keep his wife and child with him in any small or big town. This brings prestige to the father. The young man was no more a cultivator. That reproach has been washed out. He was a middle-class gentleman. In this way, the middle class gentry was being created and was being annually added to the crowd of exploiters, till, by now, the question of unemployment amongst the middle class has become a new and acute aftermath of the method of peaceful exploitation.

I have put the money-earning capacity of the cultivator's lad at Rs. 25/-. But by chance he may get better posts. He may earn Rs. 225/- per month. Even if one in ten thousands will do that, the rest, the 9,999 will aspire for it and strive to follow the same track tenaciously. Exploitation is at the root of the educational system of India. Lads are sent to school not to acquire knowledge nor with the object of making them good and useful members of society ; these are not the objectives. (568-'74, 597)

16. Education suited to agricultural welfare : In free countries where agricultural welfare means welfare of the nation, things are shaped differently. A set of pictures from a book on dairy enterprise tells the tale of how things develop in America.

"These several pictures prepared by the Federal Board for Vocational Education tell a true story in staged pictures of how vocational education in agriculture functions. A vocational student started in the dairy enterprise by buying a pure-bred Gurnsey heifer with the proceeds of a poultry project. He studied, gained experience, helped his

father to build up a pure-bred dairy herd and shared in the managerial and financial responsibilities of the developed dairy.”—(P. 11.—*Diary Enterprises*—McDowell & Field.)

This is as it should be. For, in that country education is not directed to the purpose of maintaining exploitation. In India of 1890 as in India of today, agriculture was the least paying of all vocations. The cultivator cannot make both his ends meet, however clever and painstaking he might be. He sinks deeper and deeper into debt. Legislation after legislation has been enacted to save the cultivator from his appalling load of debt. But so long as the root cause remains, so long as the administrative order continues to be what it is, there is no prospect of the type of education changing or the profession of agriculture and animal husbandry becoming attractive.

17. **Saidapet Agricultural College, Madras :** In the report of Dr. Voelcker mention is made of a college at Saidapet, Madras :

“The Madras Agricultural Committee (1890) reported that the results of agricultural education at the Saidapet College were disappointing, and that the sole object of most of the students joining the College was to obtain employment or promotion in Government service, very few indeed of them subsequently engaging in farming.”—(P. 382)

The reason is clear. Farming under the circumstances in which the cultivators are placed, does not pay. And what was true about the Saidapet College

in 1890 is true of all the Agricultural Colleges today in India. The report of the Royal Commission on Agriculture (1927) mentioned this :

"An overwhelming portion of those who receive their training at agricultural colleges enter public service in the Agricultural Departments and a comparatively few join the college with the object of fitting themselves to farm on their own account or in the hope of employment in large farms and estates."

This proves that that position has remained unchanged.

18. The gulf between Government and people : The Government and the people are two distinct units. While the people remain apathetic, the Government has been trying to improve and make efficient the laboratory and official side of agriculture. An efficient Research Institute has been established by Government and solid researches in veterinary science, in immunisation, in feeding and breeding and clinics are being conducted. This is the easiest portion of it. The Government spends money, creates services, and gets hold of the most efficient men in India and brings over others from England to carry on necessary work. Able and faithful men do their job assiduously, and in consequence a mass of very valuable literature has been created. But most part of this knowledge remains recorded in the scientific bulletins and files, and fills the shelves. They do not filter down to the fields to enrich the cultivators as they should, because the Government is cut off

from the cultivator and also because in basic matters their interests clash. The Government is seriously faced with the fact that veterinary and animal husbandry work done in the laboratory do not reach the cultivator, at least fall far short of what it should be. This is entirely due to the separation between the Government-cum-the-middle-classes on the one hand and the cultivators on the other hand.

His Excellency Sir M. Hallett, Governor of the United Provinces, in opening the Fourth Meeting of the Animal Husbandry Wing of the Board of Agriculture and Animal Husbandry, held in November, 1940, touched upon this subject and admitted that the Government is not trusted by the *raiya*t and that what the Government cannot do may be rendered possible through non-official agencies.

The first item on the agenda ran thus : "To review the present methods of *disseminating* amongst the rural population the latest informations regarding the management of different kinds of live-stock and make suggestions for its improvement." Upon this, His Excellency the Governor observed :

"Your first item is a consideration of the present methods of disseminating amongst the rural population the latest information regarding the management of different kinds of live-stock and of suggestions for improvement. If a farmer is to become interested in improved methods of cultivation, in improved methods of animal husbandry, success is only possible by ocular demonstration. It is necessary to show that the

products of a particular improved method are superior to the products of the methods of centuries, and that is indeed a difficult task. It needs widespread organisation and if that organisation is paid for by Government it means a lot of money and we have not got the money. But I am never prepared to drop a scheme if it is really worth carrying out and is not mere eye-wash, merely because my Finance Department say that no money is available. There are often other methods of securing some success. We must also remember that in this country the conservative and illiterate cultivator is suspicious of direct Government propaganda ; he is often afraid that the improvement suggested, if he adopts it, will mean an increase in rent or land revenue. (19) We must, therefore, make use of our educated land-holders and others to spread our ideas."

Sir Maurice indulged in platitudes. On a ceremonial occasion this was perhaps inevitable. Otherwise, the Governor of the U. P. could not have come down upon the cultivator for his illiteracy and his suspicions. The U. P. cultivator demonstrated beyond all doubt that when the Government was really willing to give something for his benefit by way of improved methods within his means, he was very prompt to take it up. The whole phase of sugar cultivation changed in the U. P. in course of 3 or 4 years ; every new variety of sugar cane introduced was taken up with absolute promptness as cuttings were supplied ; and when in course of time something

better was offered in place of the last new variety, the newer ones were taken up with equal zeal as soon as the cuttings were supplied. It is altogether out of place to chide the cultivator. The real thing is that the Government itself does not know in most cases the value of what is offered and also if it is within the reach of and suitable for the farmer. (264-65, 398)

19. Agricultural improvements and revenue enhancement : The discussion that followed on this subject wholly supported the fact that it was the Government which was lacking and not the cultivator. At that very meeting Mr. Mankar of Bombay said :

“Propaganda proves responsive, such as good bulls and cows as foundation stock. But as there is yet no definite source from which to meet demands, no constructive work of improvement can be begun, and hence the interest created by propaganda comes to nothing but temporary awakening. There should be a link between propaganda and the supply of the means of improvment.”

Mr. Bruen, Live-stock expert, Government of Bombay, said ; “Another great difficulty why propaganda failed to take root in the villages was that the moment some improvement was seen an *increase in the revenue* was imposed.”

Thus what was mentioned by Sir Maurice Hallett as an unreasonable suspicion of the cultivator about increase of revenue, was shown by Mr. Bruen to be too real. And this in Bombay where the Government is the direct authority for imposing enhancement of revenue !

The cultivator has been deprived of the capacity for maintaining agricultural improvements by circumstances beyond his control. It is no good blaming him for his illiteracy or for his religious sentiments or for his conservatism. If he is illiterate it is the State that is to blame and not he.

20. Problem of the cow insoluble ? : We have traced certain of the processes that have worked towards rural decay, towards the deterioration of agriculture and of the cow which is the handmaid of rural life. We are convinced that restoring health to the cow will revive agriculture and village life. But, according to official opinion, the problem of the Indian cow is insoluble. The last Royal Agricultural Commission brought out the situation in these words :

“We are of opinion that the census figures suggest the evidence of a vicious circle. The number of cattle within a district depends upon and is regulated by the demands for bullocks. The worse the conditions for rearing efficient cattle are, the greater the numbers kept tend to be. Cows become less fertile, and their calves become undersized and do not satisfy cultivators who, in the attempt to secure useful bullocks, breed more and more cattle. As numbers increase or as the increase of tillage encroaches on the better grazing land, the pressure on the available supply of food leads to still further poverty in cows, and a stage is reached when oxen from other provinces or male buffaloes are brought in to assist in cultivation. This stage has been reached in Bengal. The cows

of that province are no longer equal to what, in any reasonably managed herd, would be an easy task. But, as the male buffalo is either not available or is not suited to ordinary field work, large numbers of oxen are imported to supplement those locally bred. As cattle grow smaller in size and greater in number, the rate at which conditions become worse for breeding good live-stock is accelerated. For, it must not be supposed that the food required by a hundred small cattle is the same in quantity as that needed by fifty of double size. As cattle become smaller the amount of food, needed in proportion to their size, increases. Thus if a certain weight of fodder maintained 100 cattle weighing 10 cwts. each for a year, the same supply would last 200 cattle weighing 5 cwts each only for about 8 months. Large numbers of diminutive cattle are, therefore, a serious drain on a country in which the fodder supply is so scarce at certain seasons of the year as it is in India.

"The process has gone so far that India has acquired so *large a cattle population* and the size of the animal in many tracts is so small that the task of reversing the process of deterioration and of improving the live-stock of this country is now a gigantic one ; but on improvement of cattle depends to a degree, that is little understood, the prosperity of agriculture ; and the task must be faced."—(P. 191)

Then again : "....., it will be useful to examine the subject of live-stock improvement from the

cultivator's point of view. That the cattle of India are *deteriorating* for reasons partly though not entirely outside his *control* is the view of a number of experienced witnesses who gave evidence before us. This process must be arrested if the cultivator's position is not to suffer."—(P. 199)

In order to alter the position the Commission thought that the mental attitude of the cultivator regarding his responsibility for maintaining his cattle in a fit condition must be changed. He must sell off the cattle if he cannot maintain them. It is not understood what his mentality has to do with his inability to better feed his cows. Selling off the cattle as suggested in the Report is no solution. The buyer will be able to do no better, and the cultivator who could not afford to feed his herd properly for want of means can still less afford to keep his land fallow after disposing of his herd. So this is no solution. Other factors of the problem intrude as the Commission recognized.

"Apart from fodder shortage the cultivator's efforts to improve his stock may be nullified by an outbreak of contagious disease. It is, indeed, the *loss* from *disease* that tempts many to keep a *larger stock* than is absolutely necessary, and this increases the difficulty of feeding properly."—(P. 200)

The Report has found no solution for removing this difficulty. Efforts are being made by the Government to combat the devastating diseases. But at the moment the Government is hopelessly under-staffed to undertake general measures for ensuring immunity,

and the methods suggested for combating are still in an experimental stage—there being diametrically opposite opinions about the methods to be used and their efficiency. The cultivator, therefore, remains equally helpless in the matter of reducing the number of his cattle.

The report concluded that breeding depends upon feeding, at least feeding is the prior necessity. Without proper feeding there can be no question of improved breeding or improvement of stock. The whole question then comes back again to feeding or primarily grazing and secondarily grass-cutting or hay-making or growing fodder crops.

The report then considered the extension of grazing land, and came to the conclusion that by all efforts five per cent only or a little more grazing land can be obtained from forests and from uncultivated wastes. Here again negation faces the seeker after the improvement of cattle.

The report put emphasis on this vicious circle, on the evil of the conditions in which “every village is overstocked with herds of wretched, starving cattle” and of “weedy animals eating up food”. The blame is laid on the cultivator because he will not slaughter. That slaughter is no remedy is borne out by facts set out in the report itself.

21. Shortage of fodder too acute : The pitiable condition of the cow and the cow-keeper is brought out vividly in the report :

“We have now reached a point at which the position of cattle management may be summarised.

The ordinary cultivator does what he can for his plough cattle and his she-buffaloes; quite often he does well for them, but bad seasons create difficulties for even the best cultivator, and the best of his cattle. The *cow* is less fortunate; she gets *little stall-feeding* and has to seek the greater part of her food where she can; young cattle and the male off-spring of her *rival*, the she-buffalo, share her fate and pick up their livelihood on the common grazing ground or by raiding crops, and who that knows these common grazings can blame the raiders! But this raiding of crops, which is an almost universal consequence of the mismanagement of cattle in India, is very serious for the cultivator himself; it frequently presents to him the alternative of heavy losses or of sleepless nights.—(P. 197)

It is extremely wonderful that the Government does not lose its sleep even after the publication of such a picture and proceeds on as if this abnormal state is normal.

There is admittedly a shortage of fodder, and according to the report "Even when all possible use has been made of the existing sources of supply a *shortage of fodder* is likely to arise in many parts of India. The cultivation of fodder crop on the cultivator's holding is the only remedy." (P. 252) But it is only a wordy remedy—for under the prevailing conditions, for one reason or another, it is not practicable and has not been possible, although seventeen years have passed between the report and

today. With all that the Government has done, the problem has become more acute than ever today, as the deliberations of the animal husbandry experts in their wing meetings show. (Subject 24. Second meeting of the Animal Husbandry Wing of the Board of Agriculture and Animal Husbandry held in December, 1936.)

But the prospect is not really as bad as has been painted. It is not that there is absolutely no way of improving the situation, but that the Government of the day has no interest in saving the cow by measures which involve large financial responsibilities and which, according to the Government, are the only methods feasible.

The report aptly criticised the attitude of some witnesses who compared the condition of the cow in England and in India.

"In pointing to the example of Britain, as was done by one of the most prominent scientific men in India, when giving evidence before us in Bengal, it must be recalled that it was not until British cattle were, in the eighteenth century, protected by the introduction of root crops from the semi-starvation which until then had been the fate of many of them during the winter months, and not until enclosure made it possible for farmers in Britain to control the promiscuous mating of animals, that the breeding of the livestock, for which that country is now famous, became possible."—(P. 200).
(386-'91, 591)

22. **Feeding can improve cattle:** So, cattle improvement in England begun a hundred or two hundred years ago only. There is hope for us yet. It is well-known that given fodder and proper nourishment the cattle will improve as if by magic. In this land of starving men and starving cows it is within the experience of many that a little added nourishment goes a long way towards improvement. In his note on the subject of fodder and the fodder resources of India, Mr. Read, Assistant Superintendent, Cattle Fodder Farm, Hissar, writes :

“To those anxious to make progress in the improvement of live-stock, who are unable at present to procure first class animals for stud, some work on feeding problems might be suggested. Money, time and labour spent on improving feeds and feeding would not be wasted. Quite mediocre live-stock will quickly *respond to better feeding* and a well-nourshed animal will produce better progeny than her less fortunate sister.” (Proceedings of the second meeting of the Animal Husbandry Wing of the Board of Agriculture, 1936. P. 172)

Years ago, I went to a village and saw a wretched cow in the house of one of our workers. I wanted to know what the matter was. The cow was only skin and bone, and hardly able to move about. I learnt that she had not borne any calves these two or three years, and that she was a drag on the slender resources of straw for the herd. I took pity on her. I understood that probably she had failed to conceive because of malnutrition. And because she had failed to conceive

she had little share of the feed of straw at stall. She could not graze freely like others of the herd, weak as she was, and was getting more and more reduced. I got her for the asking. It was the taking off of a load from the family. Our working centre was only 5 miles away. Lakshmi, that was her name, was brought in and given the usual feed. She put on flesh and a glistening coat of fur. In three months she came to heat and afterwards gave a calf and also gave milk for the dairy. How often have I looked on at the wretched condition of men, women and children and connected the condition directly to malnutrition. A little additional nutrition makes a world of difference. It is the same with the cow as with human beings. The nutrition of men and of the cow is indissolubly connected. Where the cows are starved the men are starved, where the cows are prosperous men also are prosperous and the reverse also is true.

I thought that the example of *Laksmi* would be an object-lesson to the locality from which she was brought and to the locality where she was kept. But to my amazement I found that my success with the experiment of Laksmi made no impression on the cultivators to whom the object lesson was held up. They knew all that, they said ; but how were they going to feed as I had fed ?

If we believe that there is future for Indian men and women, there is a future for the Indian cows also. But it is not on generalisations alone that one is asked to depend. The Report of the Royal Commission on Agriculture gives food for thinking.

Is the condition, one may ask, gone past remedy, as it seemed to suggest? In the Report there are certain remarks regarding the future of cattle and an uncanny impression is left in the mind that despite what has been said about efforts for improvement, the real situation is beyond repair. *Slaughter* is the only *remedy* and the Indian cultivator would not take to beef-eating and to slaughtering as they do in other countries. They breed dual-purpose cows for milk as long as milking is profitable, then for slaughter for beef. If the Indian cultivator will not accept this position there is little hope for him. Certainly there is no possibility of India taking to beef-eating even if it be for saving the cow.

Even on the item of better feeding there is a lurking suspicion that *better feeding* will also lead to the same *disaster* by making the cows more productive and increasing the number and making the extra facilities rapidly fall short of the requirement. In the words of the Commission it was put as under :

“Since it is the curtailment of uncultivated land as population has increased during the past century that is the most obvious cause of the present over-stocking of village grazing grounds, it is not surprising that many witnesses have advocated the extension of grazing land. It is understood that given certain conditions such an extension will relieve the situation. If the number of *cattle* were *not to increase*, if a sufficient area of grazing land could be found to carry the existing stock easily in normal seasons, if

provisions were made for supplementary fodder in years of scarcity, then it would not be a difficult task for the skilled grazier, first of all to add greatly to the output of the grazing grounds by stocking them in rotation, and subsequently to effect marked improvement in the quality of the cattle."—(P. 201). (379-'84)

23. Royal Commission's conditions for improvement unfulfilable: Finally, therefore, the Commission laid down three criteria for the improvement of cattle by proper feeding (grazing) subject to the following conditions :

- (1) The number of cattle is not to increase ;
- (2) Sufficient grazing areas to be found ;
- (3) Provision for supplementary fodder in times of scarcity be made. The Royal Commission after discussion concluded that none of the conditions can be fulfilled.

(1) The number of cattle is not to increase : This is impossible unless the number is kept down by slaughter or by disease. Disease is not contemplated. About reproduction it was regretted by the Commission that in strange contrast, human beings were more prolific in India than the cattle, whereas in England the cattle were more prolific than human beings. The want of quicker reproduction is regarded as a drawback. If we want more reproduction and yet want to restrict the number, it means we need *slaughter*. Universal slaughtering cannot take place. Therefore, the first condition of restricting the number of cattle is not possible of attainment.

(2) Availability of *grazing land*: The Royal Commission itself has shown that only 5% *increase* in grazing area is possible. This conditions is, therefore, also unfulfillable.

(3) Provision of supplementary fodder in years of scarcity: This also is practically and materially unfulfillable under the existing conditions as shown by the Royal Commission.

After a consideration of these items it tried to bring it home to the enquirer that there is no future for the cow and the cultivator in India. Ruin faces them.

A searching enquirer sees nothing but negation in the matter of improvement of cattle, as discussed and brought out in this Report. The Royal Commission on Agriculture is a land-mark in the history of agricultural and cattle improvement in India. It cost the country thirteen lacs of rupees. The Commission had before it all the official papers and statistics on the subjects dealt with and had the advantage of examining all concerned who were likely to help in arriving at the findings of the Commission. It is a mine of information on agricultural and live-stock matters. The Commission's recommendations are being given effect to by the Government of India. I believe the recommendations are binding on the Government. Services and Research Institutes and Educational Institutes are being created by the Indian Government on its recommendation. Therefore, the findings of the Royal Commission must be given the place of importance they deserved.

24. Birdwood's sketch of industrial village-life: As already pointed out, regarding the improvement of the cultivator's cow, the Commission's findings are a counsel of despair.

But there are other outlooks which were not brought out by the Commission, and certainly there is a way for the improvement of the condition of the Indian cultivator and of the cow in India outside the ground covered by the Commission.

Why should one despair of the increasing number of cows? The reason is that they cannot be fed now. But we need not take that as the healthy or normal condition. The *land can support* both the increased burden of the cows and men if only what belongs to the land is given back to it, and if only the surplus agriculturists are absorbed in the time-honoured crafts or industries of the villages of India.

Birdwood drew a picture of an Indian village. It is a picture of the conditions that prevailed 63 years ago :

"The social and moral evils of the introduction of machinery into India are likely to be still greater. At present the industries of India are carried on all over the country, although hand-weaving is everywhere languishing in the unequal competition with Manchester and the Presidency Mills. But in every Indian *village* all the traditional *handicrafts* are *still* to be found at work.

"Outside the entrance of the single village street, on an exposed rise of ground, the hereditary potter sits by his wheel, moulding the swift

revolving clay by the natural curves of his hands. At the back of the houses which form the low irregular street there are two or three looms at work in blue and scarlet and gold, the acacia trees, the yellow flowers of which drop fast on the webs as they are being worked. In the street the brass and copper-smiths are hammering away at their pots and pans, and further down, in the *verandah* of the rich-man's house, is the jeweller working rupees and gold mohrs into fair jewellery, gold and silver ear-rings, and round tires like the moon, bracelets and tablets and nose-rings, and tinkling ornaments for the feet, taking his design from the fruits and flowers round him or from the traditional forms represented in the paintings and carvings of the great temple, which rises over the grove of mangoes and palms at the end of the street, above the lotus-covered village tank. At half past three or four in the afternoon the whole street is lighted up by the moving robes of the women going down to draw water from the tank, each with two or three water jars on her head, and so while they are going and returning in single file, the scene glows like Titan's canvas and moves like the stately procession of the panathenaic frieze.

"Later, the men drive in the mild grey kine from the moaning plain, the looms are folded up, the copper-smiths are silent, the elders gather in the gate, the lights begin to glimmer in the fast-falling darkness, the feasting and music are heard

on every side, and late into the night the songs^{*} are sung from the *Ramayana* or *Mahabharata*. The next morning with sunrise, after the simple ablutions and adorations performed in the open air before the houses, the same day begins again." (*The Industrial Arts of India*—G. C. M. Birdwood. (1880). P. 135)

What has happened during this brief *span of 63 years* in the life of a nation that we say men are not able to maintain themselves and have to go without food ; the villages are ruined and the position of the cow has become such that her progeny must be kept down by regular slaughter in order to make it possible for some of them to live ? (26, 412, 528, 544, 579)

25. Cow-slaughter to remove over-stocking : 'There have been numerous propounders of the theory of over-production of the cow and numerous advocates of the *slaughter of the cow*. The advocates themselves are probably not beef-eaters, but they see in the position of the cow a paradox for which they accept the official cry of over-stocking and repeat the remedy of slaughter, knowing all the time that the remedy is no remedy, because in spite of all their writings they cannot make the Indian cultivator slaughter-minded.

Capt. Agarwallah of the Punjab Veterinary College in his book "A Laboratory Manual of Milk Inspection" (1940) goes out of his way to condemn the civilisation that does not want to take advantage of the doubtful economic benefits of the slaughter of cow :

"The more civilized Westerner recognises this economic situation and reaps the benefits. The position of the cattle industry in India on the other hand is curious. An overwhelming majority of the population of the country holds the cow in extreme veneration and love, purely on sentimental grounds, and owing to this the elimination of the useless animals is rendered an impossibility. The result is that many millions of cattle are economically unprofitable and mean a heavy drain on the resources of the people. On a rough estimate, there are 15,00,0000 cattle which are *useless and are of no value* whatever. If the life of the animal is taken at 5 years and the value of food consumed by each at Rs. 10/- per annum, the total money spent, apparently without any profit, would amount to Rs. 75,00,00,000 annually. *

"This is a very conservative estimate, but it is enough to demonstrate the cause of the poverty of the Indian people. *Useless animals consume* the food that is needed for useful animals. It is not the cow here that is keeping the people, but the people are keeping her, whereas its reverse should be the case." And so on.

Dr. Radha Kamal Mukerjee writing on Indian Economics makes similar observations and holds

* Evidently the calculation is wrong. In any one year, according to the professor, there are 15 million useless animals and the feeding expenses should be 150 millions annually at Rs. 10/- per annum, and not 750 millions. Every year one-fifth of the 15 millions die, and another equal number gets added. I think that is what the learned professor should have said.

the theory that the cow should be slaughtered to save the cow. This has been dealt with in the introductory portion of this book.

Economy is not the last word in *human life*, not even in the much-advertised Western civilisation. Our old parents are economic burdens. They consume food and give no return. The villager is already poor and getting poorer daily. What food should have gone to feed the workable men is eaten away by old and economically useless men. By the same chain of economic arguments as advanced by the aforementioned professor and many others, the uneconomic old parents of men should be quietly disposed of. That they are an economic burden no economist supporter of the useless-cow-slaughter theory can deny. (136-'40)

26. Cows weedy because of lost village industries : But these learned professors and others have not paused to ask the question—why has this condition come to be? What has happened in the economic life of the cultivator that his cows must grow weedy and must be *slaughtered*? Why should an economist dread an increase in the cattle-population instead of welcoming it?

The palpable and evident reason is that there is not enough fodder and that for the work required they are unnecessary. But the bullocks, if not required for agriculture, can be utilised for hauling carts and milling oil-seeds and crushing sugar cane. These works the *bullock* used to do. You have taken away their *occupation* by employing steam power, and

now advocate slaughter ! By the same process the introduction of steam boats has taken away the occupation of the boat-man. The introduction of the rice mills and of the cotton mills has taken away the occupation of women, and hundred other *occupations*, too numerous to name here, have been taken away by the *introduction of steam and electric power*. The weaver, the potter, the spinner, the upholsterer, the groom, the soap maker, the paper maker, the glass maker, the metal workers etc. have been thrown out of occupation. On the same theory of the slaughter of useless cows, we should slaughter this now economically useless surplus population. It is clearly admitted that the villagers, deprived of their cottage industries, are thrown entirely on the soil which does not need them. Fifty percent of their working-time in the year is spent in idleness. Make short work of this fifty percent of the population and clear the way to India's prosperity ! But this is the wrong way to proceed. If the railways *encroach* upon the life of the cow, stop the railways from doing so. Enhance Railway rates so as to make a carter's job paying and thereby make the carter and the bullock both live happily as they used to do, as described in that sketch of Birdwood.

This is one aspect—giving of work to the bullock, the giving of what has been taken away and adding more work if there are more animals to feed. (24, 412, 528, 544, 579)

27. Robbery of the soil : Another aspect is the stoppage of the robbery of the soil that has been

going on under a system of smooth exploitation. If we want more cows to live on the same acreage, then we should make the same acreage yield more. We have not reached the limit of the yielding capacity of the soil. By manuring the soil the yielding capacity may be doubled and trebled and this may solve the problem. The cow produces manure. Cow-dung is burnt and is not returned to the soil. This economic loss has to be stopped. The cultivator is not to be blamed for *burning* his golden *manure* for fuel. He knows its value full well. But out of necessity, because there is no other fuel, he is forced to burn manure. (479, 547-'52, 597)

28. **Supply fuel ; save manure, said Voelcker :** Dr. Voelcker made a strong case for free or almost free supply of wood for domestic purposes to save cowdung for manure. He made definite proposals for the creation of fuel and fodder reserves for this purpose. The Royal Commission of 1927 quoted Voelcker with regard to manure, but passed by the very important and practical suggestions which he had made for meeting the situation. In fact, the most prominent outcome of the tour of enquiry of Dr. Voelcker was a case for the Government to step in, to preserve cowdung and oil cakes for manure and for feeding purposes. He proposed to make these supplies a matter of charge on the State. He acknowledged that linseed export impoverished India, although he appreciated the use of Indian linseed in England for the maintenance of the cattle. In other words, he was for sacrificing the immediate interest

of England for the purpose of saving the cow in India. It is worth-while to quote Dr. Voelcker's opinions extensively in this matter, because the situation has changed for the worse by the years that have passed by and because his recommendations on this head are constructive recommendations for saving the cow and, therefore, of saving the agriculturist of India from ruin.

The one cry of Dr. Voelcker was to give back to the land what was its due, so that the land might maintain the cows and men dependent on it. It is the duty of the State to undertake the expenses and make the necessary provisions to accomplish this. (411, 444, 462, 479, 547-'51, 577)

29. Oil seed exports and transportation of soil fertility : About the prohibition of export of oil seeds and oil cakes, which he called transportation of fertility from India, Dr. Voelcker observed :

"Now it is clear that as these seeds * are for the greater part exported, the export must imply the removal of a very considerable amount of the constituents of the soil. Were they (with the exception of castor-oil seed) to be consumed by cattle, after expression of the oil, the manurial constituents would be returned to the soil from which they were drawn, and the balance of fertility might be maintained. The oil itself having no manurial properties and being derived from the atmosphere and not from the soil, is a fitting object for export ; but to send away the entire seed or

* Gingely, Earth-nut, Linseed. which is entirely an export crop, cotton seed, mohua seeds etc.

refuse after removal of the oil, is to send away the valuable manurial constituents contained in the seed, including those taken out of the soil itself ; in brief, to export them is to export the soil's fertility. The answer given will doubtless be that there is the advantage of the *ready cash* obtained in exchange ; but it becomes the duty of Agricultural Departments and of Experimental Farms in particular to demonstrate clearly to the people what the advantages are of using such refuse materials, either as food for cattle, and thus indirectly as manure, or else by direct application to the land. Where, as in India, supplies of manure in any form are so short, it seems wrong to allow so much manurial element to be carried beyond the seas, without endeavouring to establish its value and the importance of retaining it in the country. We in England are not slow to avail ourselves of the advantages this export system offers ; and at the time of my leaving for India I was feeding bullocks at the Woburn Experimental Farm on linseed cake, and was also growing crops with rape cake manure. Both these materials, in all likelihood, were the produce of Indian soil, and represented its transported fertility.”—(P. 106). (462, 479, 547, 551)

30. Cowdung the supreme manure : its value :
Regarding cowdung as manure, Dr. Voelcker said :

“The most general manure alike in India and in England is cattle manure, or as made in England,

farm yard manure. But, whilst in the latter country it has to be, and can be, supplemented and even in part replaced by artificial manures, this is not the case in India, and cattle manure is the universal fertiliser and often the only one available. When, therefore, we find it the general practice, even in villages, to burn a large portion of the dung from cattle as fuel,.....we cannot but pause to ask ourselves whether the burning of these (cow-dung) cakes as fuel does not imply a great agricultural loss."—(P. 96)

Dr. Voelcker analysed Indian cowdung and found one ton of dried cowdung to be equivalent to 155 lbs of Sulphate of ammonia in its manurial value. Now, if one animal on the average give 4 lbs dry droppings daily, the total of dry droppings of bovine animals will be more than one crore of rupees worth in ammonium sulphate per day. This will be equivalent to over 360 crores of rupees worth of manure yearly. If these Rs. 360 crores worth of ammonia were retained in the soil it would lead to fabulous sums in the increased value of the outturn from the fields. This has to be conserved. Dr. Voelcker wrote :

"I have spoken of the practice of burning dung as being a general one, and so it unfortunately is, but it is very far from being an universal practice among cultivators pure and simple. I would go farther and say that the best cultivators do not burn dung except out of sheer necessity, and because they have nothing else for fuel, and then

even amongst second-rate cultivators a great majority will not burn dung if they can help it. Perhaps, in all my enquires there was none into which I looked more closely than this, as I have heard and read such diverse opinions about it ; consequently wherever I went, I did my best to inform myself upon it. As the result, I have no hesitation whatever in saying that amongst *cultivators* the reason why they burn dung is that they have no wood ; and that if wood could be made cheap and accessible to them there would be an enormous increase in the amount of manure available for the soil. I can instance place after place which I have visited and where no cultivator burns a scrap of manure for fuel or where the least possible quantity is so used—generally only a little to boil milk.”—(P. P. 100-01)

And again, “As the result of my enquires I feel I may safely assert that where the practice of burning dung as fuel prevails among the *genuine* cultivators, it arises, in eight cases out of ten, from the scarcity of fire wood.”—(P. 103). (358, 462, 470)

31. Free fuel supply, the one recommendation of Voelcker : “In the last chapter after reviewing the various sources of manure supply we saw that they were very limited in number and that the only material available in any quantity was the ordinary cattle-dung. Further, we found that wherever wood was sufficiently abundant dung was used for the land, and it was not burnt ; but that where wood was deficient, manure was burnt in

the absence of any other source of fuel, and that the land was then deprived of it. The dependence of the soil for its fertility upon the supply of water and of manure was also instanced. The conclusion was, accordingly, drawn that the supply of wood to serve as fuel forms one of the most important factors in maintaining the fertility of the soil, or, in other words, the prosperity of agriculture. I can hardly put this too strongly, for it is *the one* practical measure on which I place the most importance ; it is that which calls for the most urgent attention and from which the greatest benefits may be expected to follow. I make in my Report other recommendations and suggestions, it is true, but I consider them *minor* ones compared with this. Let us once more review the position. A country exporting manures as well as crops, not utilising even the night-soil, and then burning the cattle-dung because fuel is scarce ; an ever-increasing population and a greater demand on the land to supply more and larger crops, these latter depending on more manure being available. What more ready plan than to supply wood as fuel in order to save the manure for the land ? In the substitution of wood for cowdung no question of caste prejudice is involved such as is the case in the use of bones or of night-soil. It is a measure which the people would adopt and have adopted on their own account wherever it has been possible. Further, the improvement thus to be effected is one which proceeds upon the right lines,

viz., the improvement of Indian Agriculture from *within* rather than from *without*.—(P. P. 136-37). (444, 453, 462, 577)

32. As water was supplied by the State so should fuel be supplied : “I, therefore, do not hesitate to say that, just as Government foresaw the difficulties of the people in supplying themselves with water and so provided it for them, so must attention be now turned to the difficulties of the people in the matter of fuel, and seeing how impossible it is for them to provide it for themselves Government must do this for them too. It is not in the interests of the people alone that I would urge this, for, having fully discussed all other ways of increasing the manure supply, it is clear that this is *the one way* in which it can be effected, and, if not effected, sooner or later the land must fall off in productive power and the revenue derived therefrom by the State must decline too. Accordingly, I regard the provision of fuel as the most potent means of maintaining prosperity, not alone to the cultivators, but to the *State* itself and as a measure, which the latter, *in its own interests*, should take up immediately. If wood could be made to take the place of dung for fuel we should soon come to realise that more wood means more manure, that more manure means more crops and more crops an increasing revenue to the State ; whilst to the cultivator, it implies more fodder, better cattle and more manure again to ensure the future fertility of the soil.”—(P. 137)

"I do not take to myself credit for more than emphasising what others have already pointed out on this subject. As much as 17 years ago Mr. R. H. Elliot, writing in the *Times*, urged the necessity of "Fuel Reserves" for India, and much that he then said has since proved to be true. The same views have been urged by others, but there is call now for more definite action than there has been in the past."—(P. P. 137-38)

The Government of India of that time felt the necessity of providing fuel reserves and recommended that the purchase of land should be effected provided the price came within a limit of Rs. 20,000 for 10 square miles. The actual management of the 'Reserves' was intended to be in the hands of the Forest Department. Enquires were made by the Government as to whether "Fuel and Fodder Reserves" existed along canal banks and lines of Railway. But it appears that the matter was not followed up, and by the time of the Royal Commission of 1927 it was a dead suggestion. The land in India continued, therefore, to be deprived of its manurial elements. (462)

33. Conserve manure for fodder crop to save the cow : In a country where the population on the average gets the least amount of milk per head, why should there be dread against the increase in the number of cows? The vicious cycle comes to the rescue with a reply that there is not enough fodder. But increase the fertility of the soil by manure from the cattle themselves, keep the fertility of the soil

to itself by prohibiting the export of oil seeds or oil cakes, utilise the bone-meal and meat-meal of dead animals instead of exporting them out of the land, learn to use the night-soil and composts. Then you will find how fertility will shoot up. The same plot that maintains ten animals will maintain twenty. In other words, out of the acreage now given to food crops, only the major part will be utilised to grow the same quantity of food and a portion of the acreage will go to grow fodder. India then will have healthy men consuming not 7 oz. of milk *per capita* but 40 oz. of milk which the people of England use.

Dr. Voelcker was clear in his implication about the saving of manure by supply of fuel. His purpose was that all wood necessary for the household purposes of the cultivator should be supplied at a nominal annual cost. He calculated that if Re. 1/- per family be realised then fuel can be allowed to be taken by the cultivator from Fuel and Fodder Reserves without loss to the Government. Even if there was a loss it should be made up from the general income of the Forest Department.

34. The two reports : I have in this chapter considered the two reports—the 1890 Report of Dr. Voelcker and the 1927 Report of the Royal Commission on Agriculture, for these are the most prominent sources of information on the matter dealt with.

The one of Dr. Voelcker is a constructive report. He emphasises on the one point—the return of manure to the soil or in general terms the return to the soil of what belongs to the soil, and the stoppage of

burning or the export of soil fertility. An agricultural chemist that he was, he brought in his chemical instinct to make a distinction between oil and the cake from the oil seeds. The oil portion of an oil seed is a material formed by the oxygen, hydrogen and carbon of the air under the influence of the life process of the plant. It is therefore, that 'oil' belongs to the air, and the oil-cake portion of the seed is made out of materials, mineral substances and nitrogen etc., furnished by the soil. He pleads for returning to the soil what belongs to the soil. This should have been done, and should be done now.

The other report, that of the Royal Commission of 1927, is barren in this respect. Its main theme is the creation of an effective Veterinary Service. Recommendations on this matter are being given effect to steadily by the Government of India, and Research stations and Educational Institutes are springing up. They are necessary. But the first necessity is to feed the cow and on this point this report has nothing but blank despair to offer.



CHAPTER II

SOME IMPORTANT BREEDS OF THE COW IN INDIA

35. Cross-breeding with European breeds : The oxen of India are zoologically different from those of Europe. The Indian oxen, cows, bulls or bullocks, have humps, which are more pronounced in the case of bulls. But the oxen of Europe have no humps. The two stocks are different. The Indian cattle is *Bos Indicus* or the *Zebu*, a humped animal. It was domesticated in China, India and East Africa, as distinct from the cattle of Europe and of north Asia which have no humps, which belong to an entirely different species—*Bos Taurus*. It has been repeatedly proved by the scientists that in the tropics cattle with Zebu blood only can thrive. (130-'35, 168-69)

36. Origin of Indian cattle : It is a matter of research now to find out the origin of the Indian cattle. One view is that the milking breeds of cattle of northern India were brought by the Aryans with themselves. These spread from north-western India to the central and the southern, the western and the eastern regions of India in course of time. Another view is that the prominent milking breeds of the cattle in India are of indigenous origin.

It is a fact that the cow, the buffalo, the elephant etc. were domesticated in India long before 3,000 B.C. In the pre-Aryan ages two varieties of cattle were found in India, the massive, long-horned and humped form and a smaller form with short horns, which may have been humpless. This latter variety is found in the upper strata of the *Mohenjodaro* site. But there are abundant remains of humped bulls in every stratum which indicate that at that time "the Indus Valley must have been specially rich in this fine breed of cattle, which is closely allied, if not identical with, the magnificent white and grey breed still common in Sindh, northern Gujarat and Rajputana, but wholly different from the small humped cattle of Central India." (*Sir John Marshall*, quoted by *Shirlaw*)

Sir Arthur Olver's contention that the grey-white breed, common in northern India, in Sind and in Bombay and Madras were brought in by the *Rigvedic invaders*, does not seem to be convincing, tested by the evidence of the *Mohenjodaro* finds. In fact, it may be that the cattle the Aryans brought with themselves were not suited to India. They might have brought in the "*Bos Taurus*" species of north Asia from where they came, and they ultimately found the indigenous breeds better and adopted them.

"The *Rigveda* describes the river *Gomal*, a tributary of the Indus, as possessing Kine; while *Mathura* the land of Krishna and his milk-maids must, undoubtedly, at one time have been famous for its milch cows. *Huient'sang* writes of 'numerous oxen'

in *Parayatra* (or Bairat), 'while the inhabitants of Sind,' he says 'supported themselves by rearing cattle'. Much later *Marco Polo* came across on the eastern shores of the Persian Gulf and found a type of cattle there unfamiliar to him, which he describes as '...a species of large white oxen, with smooth coats...horns thick and obtuse and having between the shoulders a gibbous rising or hump. ... They are beautiful animals and very strong.' These, one may legitimately infer, to have been the descendants of Indian breeds, possibly those with which Alexander the Great started on his return home from India. In Masulipatam, the same writer remarks, 'they have cattle enough'. Nicolo Conti in 15th century described wild cattle with manes and long horns as still found in great abundance in the neighbourhood of Calicut. *ABUL FAZAL* wrote : 'Every part of the Empire produces good oxen, but those of Gujarat are esteemed the best. There are also abundance of fine oxen in Bengal * and the Deccan. Many cows at Delhi gave daily 20 quarts of milk each. ... In the neighbourhood of Kashmir are the Katars, which are of a very extraordinary appearance. ... There is also a species of small oxen called *gaynee* which are well-limbed and very beautiful.' " †

* Bengal of those days meant the whole of northern India.

† From a contribution by Mrs. L. H. Shirlaw B.A, in the Indian Journal of Veterinary Science and Animal Husbandry. March, 1940.

At a much later period, about 1808, there was a general survey of the arts, industries and agriculture of India, carried out at the instance of the Government of India—(*Montgomery Martin—Eastern India.*).

There are, in this book, nice plates showing the fine animals of India from south to north. With all this literature extant, it was strange how the Government of India wasted years in fumbling with Indian breeds of cattle and in fruitless attempts to improve the cattle of India by crossing them with the humpless cattle of Europe.

37. Classes or types of breeds : Sir Arthur Olver divided the cattle of India into several broad classes or types. Although it is difficult to agree with him about his theories of the origin of the breeds of cattle in India and the circumstances of their intermixture, yet the broad general divisions in which he classified the existing breeds had much to recommend them for acceptance.

The following is after Sir Arthur Olver's broad line of classification into types :

(I) *The long-horned cattle of Mysore*, of the Amrit Mahal type, which are found in Mysore, Madras and southern Bombay with characteristic formation of head and horn.

(II) *The Gir type cattle of Kathiawar* with their various modifications as found in a very wide area of western India, from Cutch to the Nizam's dominions in the south, also in the States of Rajputana, upto the borders of the United Provinces.

These have very prominent heads and peculiar horns and are of a phlegmatic disposition as compared with the Mysore type, but have developed into a "general utility" animal for milch purpose as also for heavy, slow draught. The long pendulous ears are very peculiar, although by crossing the peculiarities get less marked.

(III) *The large white type cattle of the north*, which can again be sub-divided into two. The influence of these northern cattle can be seen practically throughout India, for there are many types of this class in areas situated so widely apart as the Punjab, the United Provinces, Madras and along the Aravali Hills. through Rajputana to Sind and Gujarat and Bombay. One type (A) has broad face. The other type (B) is narrow-faced and extends from the Punjab and U. P. to Sind.

38. III (A) **Broad-faced grey white type of the north**: Sir Arthur Olver opines that the white northern cattle of the broad-faced, lyre-horned type appears to have followed the route taken by the Rigvedic Aryan people who, after entering India by the northern passes, turned west to the north of the Aravalli range to reach Sind, Gujarat and southern Rajputana. He compares this type with the Bull represented in the *Mahenjodaro* seal. To me, however, it appears that the Bull, represented in the *Mahenjodaro* Seal, more nearly approaches the oxen of the Mysore type, specially the Kangayam Bull found in Madras.

Be that as it may, it is hazardous to say that the Bull of the *Mahenjodaro* Seal is identical with the broad-faced, lyre-horned type of the Kankrej breed.

III (B) *The second type of the narrow-faced cattle of the North*: According to Sir Arthur Olver, to this type belong the stumpy-horned breeds in which are included "the Haryana, Rath, Gaolao, and the

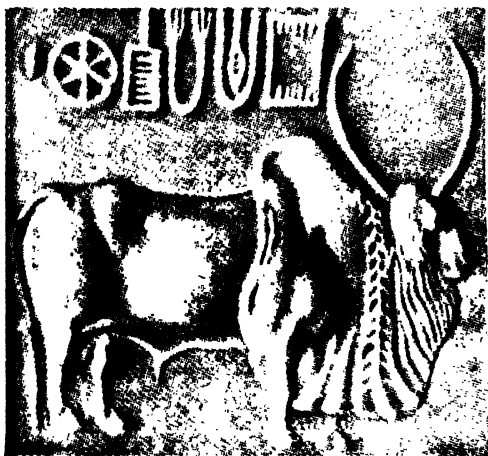


Fig. 2. Lyre-horned Malvi bull,
ca. 3000 B.C.

(Indian J. Vet. Sci. & Anim. Husband., Vol. XII, Part I)

Ongole breeds, all of which are located along the route taken by the Rigvedic Aryans from the northern passes through Central India to the south." In addition, the Bhagnari cattle also are of this type.

(IV) *The Montgomery or the Sahiwal type* of red and white mixed cattle of the Punjab: According

to Sir Arthur Olver these cattle are the descendants of the Afghan cow. They are heavy milkers.

(V) *The Dhanni type* : It is a distinct type found in the N.W. Frontier Province and forms a breed by itself.

(VI) *The Hill-type* cattle of small size and proportionately smaller head found all over India.

The Imperial Council of Agricultural Research has undertaken a survey of the important breeds of cattle, and so far many breeds with their characteristics have been catalogued.

39. The six types of breed : An attempt is made here to classify the present recognised breeds in accordance with the general lines of types set forth above. The sources of information on the breeds are the various Government publications, particularly Bulletins of the Imperial Council of Agricultural Research—Nos. 17, 46, 47, 54. The description of the breeds is mainly given here from these official publications.

I. Long-horned Mysore type

	Bulletin No.	Page No.
1. <i>Amrit Mahal</i> breed of Mysore State.	17	9
2. <i>Hallikar</i> breed of Mysore (Tumkur, Hassan and Mysore district)	17	17
3. <i>Kangayam</i> breed of Coimbatore, (Madras), maintained in purity by the Pattigar of Pallyakottai. Mixed with the blood of III (A) type.	17	19
4. <i>Khillari</i> breed of Sholapur and Satara districts of Bombay.	17	21

	Bulletin No.	Page No.
5. <i>Krishna Valley</i> breed. In the valley of the Krishna in Bombay ...	17	22
6. <i>Bargur</i> breed from Coimbatore.	54	5
7. <i>Alambadi</i> breed of Salem and Coimbatore and Hyderabad.	54	3 ^a

*II. Long-eared Gir type of the forests of
Kathiawar*

1. <i>Gir</i> breed long-eared (<i>Gir</i> , West Rajputana, Baroda, N. Bombay)	17	9
2. <i>Deoni</i> breed. N. W. and West portion of the Nizam's Dominions. Mixed <i>Gir</i> blood. ...	17	12
3. <i>Dangi</i> breed (allied to <i>Deoni</i>) of Bombay. ...	54	6
4. <i>Mehwati</i> (<i>Kosi</i>), breed Alwar, Rajputana and Bharatpur. (Mixed <i>Gir</i> blood) ...	17	24
5. <i>Nimari</i> breed of the Nerbadda Valley (cross between <i>Gir</i> and <i>Khillari</i>). ...	17	26

*III (A). Broad-faced lyre-horned, large, grey
white type of north India*

1. <i>Kankrej</i> breed. extending from Tharparker Dist. (S. W. corner) to Ahmedabad and from Deesa (east) to Radhanpur (west). One of the most-prized breeds of cattle.	17	20
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	Bulletin No.	Page No.
2. <i>Malvi</i> breed of Malwa tract of C. I. in north C. P. and N. E. of the Nizam's Dominions. ...	17	23
3. <i>Nagore</i> breed. Famous breed of trotting cattle of India of the Jodepur State.	17	25
4. <i>Tharparkar</i> breed. Medium-sized animal, of the semi-desert tracts of S. W. Sind. One of the best milch breeds of India, and also good cart animal. Those with infusion of Gir blood are not so fine. ...	17	32
5. <i>Bachaur</i> breed of Sitamarhi, Bihar.	54	4
6. <i>Ponwar</i> breed of U.P. ...	54	11

III (B). The narrow-faced, whiter, short-horned type of northern and central India

1. <i>Bhagnari</i> breed The fine cattle of Bhag in Jacobabad of Baluchistan extending to Sind, lying on the Nari river. ...	17	10
2. <i>Gaolao</i> breed of C. P. Wardha.	17	14
3. <i>Hariana</i> breed of Rhotak, Karnal, Hissar, Gurgaon of the Punjab also of Delhi. Extending to U. P., Alwar and Bharatpur. ...	17	18
4. <i>Hansi Hissar</i> breed of the Punjab	54	7
5. <i>Ongole</i> breed of Nellore. ...	17	27
6. <i>Rath</i> breed of Alwar State and Rajputana ...	17	29

	Bulletin No.	Page No.
<i>III (A) & (B)—Mixed type</i>		
1. <i>Kenwari</i> breed of U.P. ...	54	8
2. <i>Kherigarh</i> breed of the U.P. ...	54	9

*IV. Sahiwal type—mixture of Afghan &
northern India blood*

1. <i>Sahiwal</i> breed of Montgomery.	17	31
2. <i>Red Sindhi</i> breed. (mixture of Sahiwal and Gir)	17	30

V. Dhanni breed of the Frontier Province.

VI. The Hill-type of ancient India

1. <i>Siri</i> breed of Darjeeling. ...	54	12
2. <i>Lohani</i> breed of Sind and Baluchistan.	54	10

40. Long-horned Mysore type: The cattle of the Mysore type are pre-eminently fit for fast work and for endurance in the plough or on the road. They are highly strung and apt to be fierce. The cows are generally poor milkers.

The most striking characteristic of these cattle is the formation of the head and horns. The head in all cases is comparatively long with a narrow face and nostrils and the forehead is markedly prominent above the eyes.

They are as a rule not big animals and are noticeably short in the back and deep in the chest with powerful quarters.

They have established a reputation for being the most active and enduring transport animal of India.

41. (1) The Amrit Mahal breed : This is one of the best-known draught breeds of India. Its home is in the Mysore State. The Government of Mysore still maintains a selected herd of this cattle. Up till 1923, these herds were under a special department of the State and were bred for army transport purposes. After 1923, the herd of about 9,000 heads has been transferred to the Agricultural Department. The Amrit Mahals were largely used by the British forces



Fig. 3. Amrit Mahal Bullocks.
(Livestock of South India)

under the Duke of Wellington in his campaigns. They are grey in colour with dark head, neck, hump and quarter with well-defined light markings on face and dewlap. (231-'36)

42. (2) The Hallikar breed : These cattle are bred mainly in the Tumkur, Hassan and Mysore districts of the Mysore State. They are found throughout Mysore territory and form a distinct breed.

The head of these cattle is very characteristic. The forehead is prominent and furrowed in the middle. The horns emerge near each other from the top of the poll.

The cows of the Hallikar breed are better milkers than those of the Amrit Mahal breed. The characteristic is long, narrow head with prominent forehead, short, sharp ears and typical long-pointed horns.



Fig. 4. Hallikar Bull.

(Indian J. Vet. Sci. & Anim. Husb., Vol. XII, Part I)

The colour is dark grey, frequently black with light grey markings on the dewlap and under the body. The dewlap and hump are only moderately developed. (237)

43. (3) The **Kangayam** breed : They are bred in the south and south-east Talukas of Coimbatore. The Pattigar of Pallayakottai is maintaining an important

herd. It is one of the most important herds of any breeds of cattle in India.

The Kangayam breed belonging to the Mysore draught type has an admixture of the blood of the grey-white cattle of the north. They are exported in large numbers to south India and Ceylon as powerful draught-cattle of moderate size. The cows are generally poor milkers. They are said to give 10 to 12 years' service.



Fig. 5. Kangayam Bull.

(Indian J. Vet. Sci. & Anim. Husband., Vol. XII, Part I)

The prominence of their forehead is slight and the head is also of moderate size. The ears are small, pointed, and the neck is short with small dewlap and very small sheath, and a long tail reaching well below the hocks, almost touching the ground. This type has great resemblance to the Bull of the *Mahenjodaro Seal*. (212, 226-'30)

44. (4) **The Khillari breed** : This is a well-known draught breed, bred mainly in the Sholapur, the Tapti Valley, Khandesh and Satara districts of the Bombay Presidency. This is a derivative of the Amrit Mahal but is not so compact and fine, and there seems to be an admixture of blood with the grey-white cattle of the north.

They are grey-white in colour. The head is



Fig. 6. Khillari Bull.

(Indian J. Vet. Sci. & Anim. Husb., Vol. XII, Part I)

massive with long, sweeping characteristic horns. The tail is comparatively short but the dewlap is voluminous.

45. (5) **The Krishna Valley breed** : These cattle are bred in the valley of Krishna river in the southern portions of the Province of Bombay and in the Hyderabad State.

They are the animals for the black cotton soil and are reared on specially-grown fodder crops. The cows are fair milkers. The breed is not an well-fixed one as several types have gone into its composition. Although the admixture of blood with the grey-white cattle of the north is evident from colour and appearance, yet there are



Fig. 7. Krishna Valley Bull
(Indian Farming., Vol. II, No. 8)

ample indications of its origin from the Mysore draught type.

The hump is very well-developed and is placed in the front of the wither. The horns are small and curved or straight. The sheath is moderately developed and is pendulous. The dewlap is well developed. The tail is short.

46. (6) The Bargur breed : These cattle are bred extensively in the Bargur hills in the Coimbatore district of Madras. These cattle belong to the Mysore type but are smaller, more compact, and the forehead is not so prominent as in other Mysore breeds. They are very fiery, restive, and difficult to train. For spirit, power of endurance and speed in trotting they are said to be unsurpassed.

The chief colours are spots of red or white on white or red ground. Sometimes light grey colour is also met with. The cows are very poor milkers.

Their characteristics are : long head tapering towards the muzzle, the forehead is slightly prominent, horns grow backwards and upwards, fine dewlap, light sheath and rather short tail. (239)

47. (7) The Alambadi breed : These cattle are bred in the hilly tracts of north Salem and north Coimbatore districts of Madras adjoining the Mysore State, and are reared mostly on forest grazing. It may be regarded as an off-shoot of the Hallikar breed of Mysore. The bullocks are very active and hardy animals and can live on scanty rations. The cows are poor milkers.

Their characteristics are : dark grey or black colour of the bull and grey colour of the cow. The forehead is prominent and bulging and the face is long and narrow. The horns are long and sweep back. The bulls are of a loose build, with a large dewlap extending to the sheath. The northern cattle resemble the Hallikar in build and dewlap. (238, 338)

48. The Long-eared Gir type of the forests of Kathiawar : The home of these cattle is the Gir forest of south Kathiawar. These cattle in a less pure form extend over a wide area of western India from Cutch in the north to as far south as the Nizam's dominions. They are also largely bred in the western States of Rajputana, and it is also evident that they have influenced the character of the cattle at long distance, as far away as the borders of the United Province.

Its typical characteristic is a very prominent and broad forehead which forms a bony shield covering the upper part of the head and neck. The face narrows sharply and bends down at a sharp angle below the protruding forehead.

Its one great characteristic is its long pendulous ear, resembling a folded leaf, the inside facing forward. The ears curve in a pronounced spiral twist with a peculiar lobe at the end.

In the male, the upper part of the head is more prominent but the face is not so fine as in the cow. The horns are short and directed downwards and backwards.

The colouring of the Gir cattle is also very distinctive. The basic colour of the skin is white but patches of coloured hair ranging from light red to almost black are distributed over all parts of the body in most of these animals. In some, the patches of colour are large and in others they are so small that at a distance the animal may appear to be a roan. When crossed with grey white cattle this peculiar colouring generally disappears except occasionally as seen in the Mehwati breed.

The Gir influence may be generally detected in the broad bulging forehead, in the long drooping ears, in the elevated carriage of the head, in the pendulous sheath, in the peculiar shape of the horn, and in its general make-up. And these characteristics may be traced in animals from the Punjab in the north to as far south as Madras and as far east as the United Province.

In all Gir cattle another peculiarity may be found. A clearly defined patch of colour may be seen which is of a quite different shade from other patches in the same animal. This patch is liable to appear even in crossed animals in which the Gir colouration is otherwise masked.

The bony forehead gives a sleepy appearance to the eyes. They are on the whole larger animals than the Mysore type and of comparatively looser frame with a pendulous sheath and loose skin so disliked by draught-cattle breeders. (71, 318)

49. (1) **The Gir breed** : In the Gir proper, the ears resemble a curled-up leaf with a notch near the tip. The back is strong, straight and level. The hip bones are generally more prominent. The tail is long and whip-like with a black switch which reaches nearly to the ground. In pure-bred Girs the colour is seldom entire, though almost entire reds are met, with all stages of mottling of shades from red to almost black. The limbs are straight and widely placed. The cow has a long fold of skin running forward from the udder.

The Gir cows are good milkers. The bullocks are powerful animals though slow and lethargic as

compared with the trotting Mysore type. They are very extensively used as draught animals. The Girs are regular calvers, the average interval between lactations being 14 to 16 months, and the average yield in well-managed herds ranges between 3,500 to 4,000 lbs. (Report, 2nd and 3rd Delhi Show)

The best-recorded performance of the Gir cow is of the Cow, Ramon 34, belonging to the Gow Raksha



Fig. 8. Gir Bull.

(Indian J. Vet. Sci. & Anim. Husband., Vol. XII, Part I)

Mandali, Khandivle, Bombay, who at 5½ to 7 years age gave 6,000 lbs of milk in one lactation of 555 days. Another Cow, Prag Kabir 196, of the same Mandali gave 5,289 lbs of milk in 399 days during its first calving, bringing the daily average to 14.2 lbs, while the Gir Cow No. 23 of the Bangalore Institute gave 4,132 lbs in 240 days on its first calving, bringing the average to 17.2

lbs per day. Mr. Kothawalla, Imperial Dairy expert, commented thus on the Gir in 1933: "Perhaps, the oldest breed of cattle in India which has played a prominent part in the origin of some of the important Indian breeds of cattle found today. A typical dual-purpose breed which was in great demand all through the country at one time, but now very nearly exhausted due to want of controlled breeding". (318, 352)

50. The Gir in the States : In the first Cattle Show held at Delhi in 1938, the Gir Cattle were sent from Junagarh State and from the Bhawanagar State.

"In the Baroda State a herd of selected Gir cattle was established about 1890, but the original herd was unfortunately dispersed. It has recently (1926) been replaced by a new herd. This valuable breed of milk cattle had, in the interval, almost disappeared. Much difficulty was experienced in obtaining typical specimens and it is fortunate that the breed has not been altogether lost."—(Royal Commission on Agriculture, 1927 P. 222)

51. (2) The Deoni breed : This breed is mainly confined to the north-western and western portions of the Nizam's dominions. They appear to be allied to the Dangi cattle of the Presidency of Bombay. The Deoni resembles the Gir type to a considerable extent; but there is no doubt that there is other blood in its composition and, also owing to locality, it has been bred to develop differently from the Gir. The forehead and the horns are characteristic of the Gir. The colouring varies considerably, but black and white and

red and white are the most common. The typical drooping ear makes it easy to identify it with the Gir type, although in some individual animals the ear is not so characteristic of the type. The sheath is pendulous. The bullocks are good work-animals for heavy cultivation, and the cows are good milkers as compared with other breeds of the Nizam's dominions.



Fig. 9. Deoni Dongri Bull.

(Indian Farming., Vol. II, No. 8)

In the first Delhi Cattle Show the Deoni cattle were sent from the Hyderabad State, and from the Hingol Government Farm. A maximum yield of 3,000 lbs of milk has been recorded. The Hyderabad State is now developing the milking potentiality of this breed. (352)

52. . (3) The Dangi breed : The home of this breed is a small area comprising part of Ahmednagar and

Nasik districts in Bombay, and also in the States of Bansda, Dharampur, Jowhar and Dangs. It is known to do well in the heavy rainfall tracts of western India. The cattle are extremely hardy and stand well the heavy rainfall of the Western Ghats and are not affected by continuous working in the rice fields.

The Dangi is a medium, slow draught-animal, varying from 45" to 30" inches height and 58 to 60 inches in girth. The cow is a smaller animal and is a poor milker. Its colour is red and white or black and white. The skin contains an excessive amount of oil which protects it from rain. The hoof is exceptionally hardy, black and flint-like.

53. (4) The Mehwati breed : These cattle come from the western portions of the Alwar and Bharatpur States. They are valued as docile cattle and used for heavy plough and carting. The cows are fair milkers. They show Gir characteristics but also show some resemblance to the Haryana breed, indicating a mixture. They are white in colour with dark head and some individual animals show the Gir colouration. They are somewhat high in the leg. The ears and the forehead, and the narrowed-down face indicate the Gir type.

54. (5) The Nimari breed : These cattle are largely bred in the Valley of the Nerbbuda. They are much prized as active cattle. They show the Gir colouration, the peculiar formation of face and also the pendulous sheath. They seem to be a cross between the Gir and the Khillari cattle. The ears lose the peculiar Gir characteristic although they are of moderate length

and width. In general, they are red in colour with large splashes of white on various parts of the body. They have good milking qualities. (352)

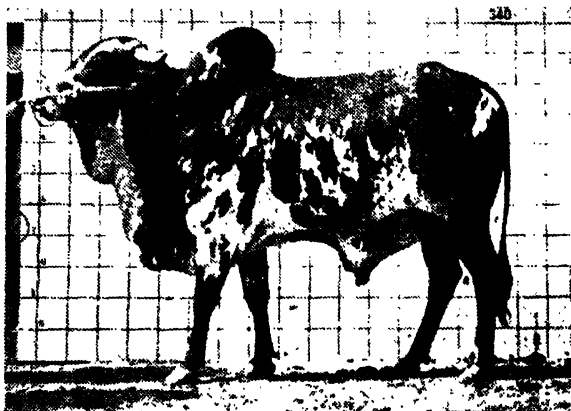


Fig. 10. Nimari Bull.

(Indian J. Vet. Sci. & Anim. Husb., Vcl. XII, Part I)

55. III (A). Broad-faced lyre-horned, large grey white type of north India : The Kankrej breed of Gujarat is its main representative. According to Sir Arthur Olver this type appears to have followed the route taken by the Rigvedic Aryan people, when, after entering India by the northern passes, they turned west, north of the Aravalli ranges, to reach Sind, Gujarat and southern Rajputana.

Of this grey, lyre-horned type the general characteristics are : short, broad face, dished between the eyes ; strong lyre-shaped horns which emerge from the poll in an outward and upward direction,

and the base of which is covered with skin more than in other types. They have loose heavy skin and are of compact heavy build with pendulous sheath and ear. The large Malvi breed of Rajputana resembles the Kankrej in certain respects, though the horns are inclined more forward in the Malvi than in the Kankrej.

56. (1) **The Kankrej breed:** The Kankrej Breed leads the type. It is one of the most-prized cattle of

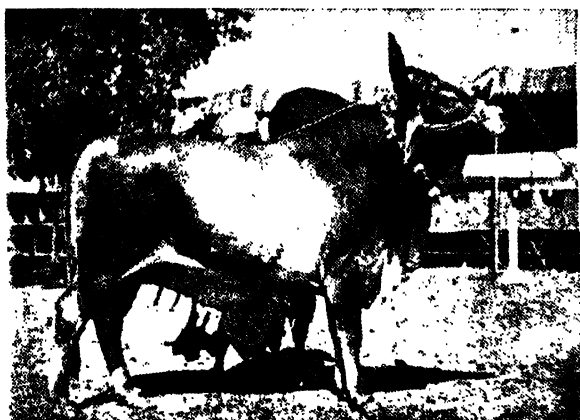


Fig. 11. Kankrej Bull.

(Indian Farming., Vol. II, No. 4)

India. Its home is the country south-east of the Rann of Cutch, extending from the S. W. corner of the Tharparkar district of Sind to Ahmedabad in Bombay in the east, to the Radhanpur State in the west, particularly along the Banas and Sarasvati rivers. In the Radhanpur State it is known as the *Wadhia* breed. These cattle emerging from their

own area have spread to Kathiawar and Baroda and Surat, where they are used for draught purposes.

They are very highly prized as fast, powerful draught-cattle and were extensively exported to America and other countries for grading up the indigenous cattle, for the creation of a tropical beef breeding type.

The Kankrej has a broad chest, a powerful body, a broad fore-head with lyre-shaped horns. These horns are attended to by breeders during development to make them thicker and let them have a coating of skin up to some height at the base of the horn. The ear is long and drooping. The skin is heavy with moderate dew-lap and pendulous sheath. The tail is comparatively short. This breed has been maintained for generations in a pure form by owners of large nomadic herds.

The recorded milk-yield of the Kankrej breed is as under : *The Cow Meghon* belonging to the Chharodi Farm, Bombay, when she was 6-8 years of age during her third lactation gave 7,259 lbs of milk in 362 days, bringing the daily average to 20.0 lbs, and *Rati* 20 of the same Farm gave 6,423 lbs of milk in 335 days, bringing the daily average to 19.0. These are very good records for any breed in this country or in Europe. The Kankrej is bred pure at the Chharodi Farm, north Gujarat (Bombay Presidency) where about 200 cows are maintained on some 2,300 acres of land.

At the Delhi Cattle Show, Kankrej Bullock No. 228, exhibited by the Baroda State, won the first prize for

the class, while a Kankrej Bull and a Kankrej Cow exhibited by the Northcote Cattle Farm, Chharodi, obtained first prize of this class and the Bull was regarded as the best bull in the Show.

Mr. Kothawalla, Imperial Dairy expert, complimented in 1933 the Kankrej breed as under : "One of the most important dual-purpose breeds in the purest form which has of recent years been bred into promising dairy strains." (302-03)

57. (2) **The Malvi breed**: These cattle are found in the comparatively dry Malwa tract of the Central



Fig. 12. Malvi Bull.

(Indian J. Vet. Sci. & Anim. Husb., Vol. XII, Part I)

India Agency. They are reared on natural grounds supplemented by special fodder-crops and grain residues. They are also bred in the northern portion of C.P. and the north-eastern section of the Nizam's dominions. They are very popular for light draught

on the roads and for cultivation. They are massive, compact animals of grey colour deepening to dark grey even to black in the neck and hump of the males. The cows and bullocks eventually become pure white with age. Their chief characteristics are : short, deep compact body, straight back and drooping quarters, powerful short limbs and feet, slightly pendulous sheath and well-developed humps. The horns emerge from the outer angles of the poll.

There are two distinct types of the Malvi breed : The big Malvi breed in the south-west of the Gwalior State and the small Malvi breed in the south-west of this area.

The cows are poor milkers.

58. (3) The Nagore breed : It is one of the most famous breeds of trotting draught-cattle of India. Its home is in the north-east of the Jodhpur State where it is carefully bred. The bullocks are big animals and are much prized as powerful trotting cattle for fast road-work. Their mart is the "Parbatsar" Fair where they fetch high prices. Their face is rather comparatively long and narrow, and the forehead is flat, their horns emerge from the outer angles of the poll. The ears are large but non-drooping. They have fine skin, a small dewlap and sheath, and a short tail.

The Cows are poor milkers.

59. (4) The Tharparkar breed : They are the animals of the arid semi-desert tracts of south-west Sind. They are also bred in large numbers in the adjoining Indian States of Cutch, Jodhpur, Jaisalmir. The area is full of sand dunes and has a low rainfall.

They are fed on scanty grazings and bushes, supplemented by grain crop residues.

They are a compact, hardy, grey-white breed. The bulls are wholly grey while young; the cows and bullocks are of lighter grey which becomes white with age. There is usually a light, grey line along the spine of the young animals.



Fig. 13. Tharparkar Cow.
(Indian Farming., Vol. IV, No. 7)

Typical Tharparkars are medium-sized animals with deep frame and strong straight limbs. This breed is proving to be one of the best milch breeds of India, while the bullocks are of medium weights, useful for plough or carting. They have several points of excellence which are making them popular. Their capacity for milk is large, their capacity for

work well-developed, and they can thrive on scanty fodder. They are being reared in Government Cattle Farms in many parts of India.

Their characteristics are : a compact, deep frame with somewhat drooping quarters, a moderately long face, a broad poll, and a slightly bulging forehead, a medium-sized hump placed straightly in front of the withers. In the female, there is a flap of skin in place of the sheath.

The first prize-winning cow and bull at the 1940 Show came from the Live-Stock Officer, Sind, Sakrand.

Mr. Kothawalla, Imperial Dairy expert, commented thus on the Tharaparkar in 1933 : "A medium-sized breed possessing dual-purpose characteristics but showing a great tendency towards high milk production and can be developed into an important dairy breed of the future."

The Tharparkar cow has a high milk record. Kumar 36 belonging to I. A. R. Institute Karnal, Punjab, gave 8,734 lbs. of milk in 313 days, bringing the daily average to 27.9 lbs ; another cow, Madhuri K. K. 397, from the Government Experimental Farm, Kanke, Ranchi (Behar) gave 7,119 lbs of milk in 304 days, bringing the daily average to 23.4 lbs. (321)

60. (5) **The Bachaur breed** : The home of these cattle is Bachaur and Koilpur Parganas of the Sitamarhi subdivision, Behar. It is essentially a draught breed. The bullocks are good work-animals. The milk-yield of the cow is poor, being only 2 to 4 lbs a day.

Their prevailing colour is grey. The animals are compact, with straight back. The fore-head is broad with prominent eyes and large, drooping ears.

61. (6) The Ponwar breed : These cattle are found in the Paranpur Tehsil of the Pillibhit district, U.P., and the north-western part of Kheri district of the U.P. The pure-bred animals possess a narrow face with long, upstanding horn, measuring 12 to 18 inches. They are generally black and white in colour. The tail is long and tapering with a white switch. The average weight of the cow is 650 lbs and of the bull 700 to 800 lbs. They are very active and often furious. They like free grazing. The bullocks are good for draught purposes. The cows are poor milkers.

62. III (B). Narrow-faced, whiter short horned type of northern and central India : This type comprises of 6 breeds :

63. (1) Bhagnari breed : The home of this breed is Sind, adjoining Baluchistan. The territory from which it comes and takes its name is the Bhag territory watered by the Nari river. The cattle are maintained on specially-grown fodder crop and on residues of grain crop, and also largely on the nutritious grass grown on the banks of the Nari river.

The Bhagnari breed has given rise to two different types : one small type, bred on the lower Nari Valley, and the other a large type, bred on the upper Nari Valley. Their colour is white to grey, deepening to almost black near the neck, the shoulders and the hump of the mature male. They are well-built, long animals, with plenty of bone and muscle. The

cows are reputed to be very good milkers; and selected cows have given quite good yields.

The Sind Report mentions that this breed is suitable for the right bank. Of the two types the medium is best for pull and milk. The milk yield (unweaned) was found of be 7 to 8 lbs per day. The best lactation

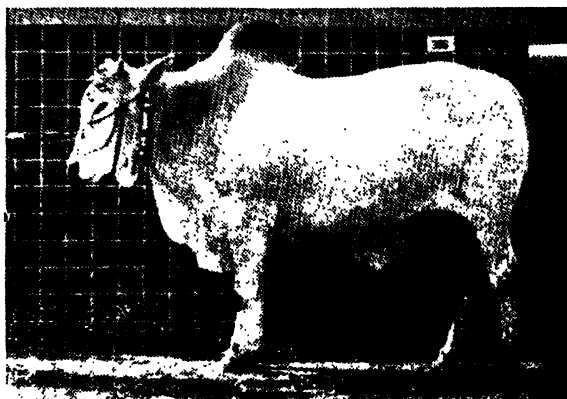


Fig. 14. Bhagnari Bull.

(Indian J. Vet. Sci. & Anim. Husb., Vol. XII, Part I)

gave 2,034 lbs. 25 cows were kept at Shahdadtote Farm in a herd 72 strong.

THE DAZZAL STRAIN: This strain is practically another name for the Bhagnari breed, extensively bred in the Dera Gazi Khan district of the Punjab. It can be traced that a hundred years ago some Bhagnari bulls were specially imported for breeding in this district, as a result of which a well-established Bhagnari strain is available in Dera Gazi Khan from where it is distributed to many parts of the Punjab.

64. (2) **The Gaolao breed :** The Gaolao is the most important breed of the Central Province and is seen at its best in Wardha, the district at the foot of the Satpuras, in the Sansar Tehsil, the Kurai Pargana, the southern portion of the Seoni Tehsil, parts of Nagpur district and Baihar Tehsil.

They are of medium height but are generally light of build tending to be narrow in frame, probably



Fig. 15. Gaolao Cow.

because of malnutrition when young. The females are usually pure white and the males are grey over the head. The head is markedly long and narrow with a straight profile tapering towards the muzzle and somewhat broader at the base of the horns. The forehead is bulging with skin folds round the eyes giving them a sleepy appearance. The horns are short and stumpy. The dewlap is large. The

males, if well-developed, make excellent work-cattle and trotters for light carts. They can endure long runs at a speed like the Khillari animals. The Gaolao cow is considered to be good milkers, although near about Wardha there are many villages having herds of Gaolao where the cows give little milk. There is every possibility of developing its milking quality by proper feeding and attention. (340)



Fig. 16. Hariana Bull.

(Indian J. Vet. Sci. & Anim. Husb., Vol. XII, Part I)

65. (3) **The Hariana breed :** The Hariana cattle are bred particularly in the Rohtak, Hissar, Karnal and Gurgaon districts of the Punjab, in the Delhi Province, and also in the Muttra district of the U.P. Large numbers are annually sent to Calcutta and other cities for milk production. The breed is found over a wide area, including U.P., Alwar and Bharatpur. Hariana bullocks are very good at rapid

road transport and at the plough. The cattle are white or grey-white. Their grey changes generally to white before the rainy season in Calcutta. In the males the neck and hump are dark. The horns of the cows and the bulls are short and stumpy ; but in the bullocks the horns develop almost to the lyre shape. The sheath and the dewlap are small, and the body is compact and strong. The tail is fine with a black switch reaching half-way between the hock and the ground.

Cow No. 18 from the Cattle Breeding Farm, Delhi, in her third lactation of 310 days gave 8,079 lbs. of milk, bringing the daily average to 26.1 lbs., while Cow No. 190/2/22 from the Government Cattle Farm, Hissar, Punjab, gave 7,068 lbs. of milk in 296 days, bringing the daily average to 21.5.

Mr. Kothawalla observed in 1933 about the Hariana : "The premier cattle breed of the Punjab. A medium, heavy type of breed which can be developed into producing dairy strains." The Hariana has achieved Dairy status since. (254)

66. (4) **The Hansi Hissar breed** : This breed belongs to the Hissar district in the area round about the river Hansi in the Punjab, whence the name Hansi Hissar. They are very similar to the Hariana breed but are stronger and more heavily built, with comparatively longer curved horns and large, loosely hanging ears. Their characteristic colour is white and grey. While the bullocks are hardy, the cows have not been able to reach the record of those of the Hariana breed. They have upto now

been distinctly regarded as draught animals, rather than milkers.

At the Delhi Show of 1940 a Hansi Hissar Bullock from the Government Cattle Farm got the first prize, and a heifer also from the same Farm got the first prize. (242)

67. (5) **The Ongole breed :** The Ongole tract in the Madras Presidency is famous for its breed of



Fig. 17. Ongole Bull.

(Indian J. Vet. Sci. & Anim. Husb., Vol. XII, Part I)

cattle. The cultivators of Guntur (Madras) generally breed them. They are fed on specially-grown fodder and grain residues. The cattle are usually docile and the bullocks are very powerful, suitable for heavy plough and cart work ; but on account of their bulk they are not regarded as useful for fast trotting.

The Ongole cattle used to be exported on an extensive scale to tropical America for improving the

local cattle by grading. They have the capacity of thriving on a scanty ration of dry fodder. Some Ongole cattle show traces of admixture with other blood through the colour patches on their skin. These heavy animals are not suitable for poor soil.

They have a comparatively long body and a short neck. Their peculiarity is their great size and their muscularity. (200, 202, 205, 214-15, 225, 291)

68. (6) The Rath breed : These are medium-sized animals coming from the Alwar State and the other neighboring States of Rajputana. Outside Alwar they are likely to be mixed with the Hariana, Nagore and the Mehwati breeds. They are very compact and active, and are suitable for medium plough and road work. The cows are also milkers. On account of the combination of these three points—medium size, suitability for draught work and good milking capacity—they are regarded as the poor man's cattle, while the Nagores are considered to be the rich man's cattle.

III (A) & III (B) MIXED TYPE : This type comprise the following two known breeds :

69. (1) The Kenwariya breed : This is a well-known breed of Bundelkhand and is found along the Ken river in the Banda district of the U. P. These animals are very popular for light draught and the plough. The cows are poor milkers. Their colour is grey.

They have a short, broad head with dished forehead, with strong, pointed horns. The horns and the general build might suggest that they show a mixture of the III (A) and III (B) varieties of type III. The horns approach the Kankrej of

type III (A)., whereas the other characteristics are those of type III (B).

70. (2) **The Kherigarh breed** : This breed is found in the Kherigarh Pargana of the Kheri district, U. P. These cattle are generally white with a small, narrow face. The horns are large, and measure 12 to 18 inches and approach the Kenwariya type. They have nearly the same characteristics as the Kenwariya breed. They are fiery and active and thrive on free grazing. The cows are poor milkers. They are well suited to the Terai tract.



Fig. 18. Afghan Cow.

(Indian J. Vet. Sci. & Anim. Husb., Vol. XII, Part I)

71. **Sahiwal type—mixture of Afghan and north Indian blood** : In the Montgomery district of the Punjab there exists a distinct type of cattle known as the Sahiwal Breed which appears to be closely allied to

the cattle of Afghanistan. These cattle are pale red or dun or parti-coloured and are amongst the best milking breeds of India. It is known that large numbers of people from Rajputana, at one time, came into this area with their cattle from the south and, therefore, it is assumed that the Montgomery has much Gir blood introduced into it by these people. The colouring shows similarity to the Afghan as well as to the Gir types.

It is also surmised that the Red Sindhi is a product of the mixture of the same two types of blood—the Afghan and the Gir. In the Red Sindhi a third mixture of blood of the cattle from the Las Bela area of Baluchistan is also traced. The type is named here Afghan-Gir type. (48)

72. (1) The Sahiwal breed : These are essentially milch cattle, which in the past were raised in large numbers in the dry central and southern areas of the Punjab. The cattle of this type are sharply distinguished from the Bhagnaris, Harianas, Nagores, and Dhannis, etc. They are usually long-limbed rather than fleshy cattle, short in the leg and of a lethargic disposition. The bullocks are useful for slow work, though it is not considered to be a good draught-animal. Owing to their milking capacity the Shahiwals are largely imported into cities. They have been bred pure in different cities in India, far from their homes and having widely different climatic conditions. Their milk records seem to show that it thrives everywhere under proper care. The following Table shows the result of breeding Sahiwals in various places :

Sahiwal—Record of milk yield

Place.	Name of Cow.	Days of Lactation.	Yield in last lactation. in lbs.	Average during lactation. in lbs.
1. Govt. Military Dairy Farm.	Belle—			
Ferozepur, Punjab.	K24/1011	331	10,087	30.5
2. C. L. Farm				
I. A. R. Inst.,	Chansuri—			
New Delhi.	653	255	8,611	33.8
3. Govt. Dairy Farm,	Ketaki—			
Telankheri, Nagpur.	5	289	7,249	25.1

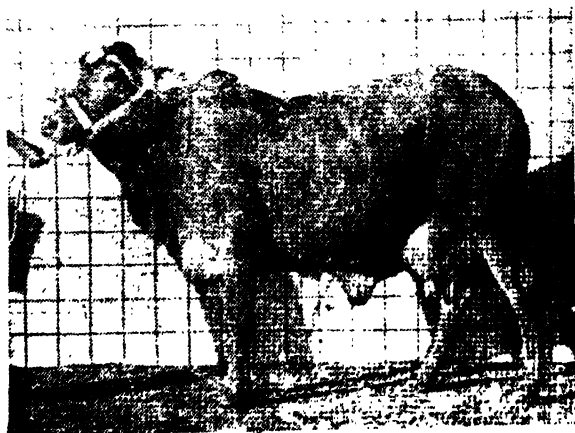


Fig. 19. Sahiwal Cow.

(Indian J. Vet. Sci. & Anim. Husb., Vol. XII, Part I)

Mr. Kothawala, Imperial Dairy expert, observed in 1933 about the Sahiwal as under :

"A medium-sized dairy breed which lost its importance due to its failure to meet the present-

day agricultural requirements of the country as the male animals are too slow and practically useless for work purpose."

Despite this observation in 1933, the Sahiwal maintains its popularity as the first-rank cow for meeting the milking needs of the cities. Much important work has been done at Pusa on this breed to raise the standard both of the cow and of the bull. (258-'63, 1055-'61)

73. (2) **The Red Sindhi breed** : The home of this breed is the country around Karachi and north-east of it. In the Las Bela area of Baluchistan a distinct type of considerable purity is bred. The Red Sindhi of



Fig. 20. Sindhi Bull.
(Indian Farming., Vol. II, No. 4)

Karachi shows distinct characteristics of the admixture of Afghan blood and also Gir blood. In Baluchistan where, perhaps, the breed is pure, it has to be regarded as a selected breed of the Hill-type of cattle.

The Red Sindhis are among the most efficient milch cattle of India. These have the advantage of being small in size and have a high capacity for milk. They can thrive anywhere and it is, therefore, that these are used for grading up the local cattle in many areas. The bullocks are small and efficient draught animals.

They are small, compact animals ; and the points for particular attention are their red or fawn colouring, frequently with some white on the face or dewlap. The ears are moderate-sized and drooping ; the udder is capacious with a tendency to be pendulous. The horns are thick and emerge laterally from the poll and curve upwards and forwards.

Red Sindhi—Record of milk yield

Place.	Name of Cow.	Lactation days.	Lactation Yield. in lbs.	Average during lactation in lbs.
Government Fruit Farm, Mirpurkhas, Sind.	Sojee-50	374	7,533	20·1
Government Milk Farm, Jubbulpore.	Kartic-86	281	6,298	22·4
Government Military Dairy Farm, Lucknow.	Saturn	461	7,825	17·0
Government Model Dairy Farm, Secundarabad, Deccan.	Shakuntala	319	8,573	26·7

The breeders of the Red Sindhi are full of praise for it.

"The Sindhi cow is one of the best for the small dairy man. It is not a large animal and it eats less food than the larger cows such as the Ongole, the Sahiwals etc. ; it is a thrifty feeder, and maintains good condition on fairly scanty rations."

In the opinion of Mr. Smith, late Imperial Dairy expert,

".....it is one of the purest and most distinct of Indian breeds of cattle. It is, however, the only breed of commercially profitable dairy cattle in this country outside of buffaloes which can be purchased in large numbers."

"The Buckingham and Carnatic mills, Madras, in 1922, disposed of their Ongole cows and purchased a small herd of Sindhi cows for their dairy, and today they have a very good herd of milking cows of pure Sind breed."

The records of the Hosur farm, Madras, where a Sindhi herd is maintained are as under :

Lactation period about 310 days, calving every 16 months. Dry about 5 months, milk yield 5,000 to 6,000 lbs., average daily 16 lbs. ; highest in a day 34 lbs. (Extract from an article by R. W. Littlewood, Deputy Director of Agriculture, Hosur Cattle Farm, Madras) •

Regarding the Red Sindhi, Mr. Kothawalla, Imperial Dairy expert, Bangalore, observed in 1933 :

"This breed is, perhaps, found in the purest state in the country today and is universally acknowledged

as the best dairy breed available and for that reason it has spread all over the country." (321-'27)

74. The Dhanni breed : According to Sir Arthur Olver, the Dhanni cattle of the Punjab should be accepted as a distinct type. He thinks that they probably came to India with a separate group of immigrants through the northern passes. They are a moderate-sized, compact breed of very active



Fig. 21. Dhanni Bull.

(Indian Farming., Vol. I, No. 9)

work-cattle of peculiar colouring which are bred in considerable numbers in the Attock, Rawalpindi and Jhelum areas of the Punjab, and in the North-West Frontier Province. The colouring of these animals is of black or red spots on a white coat, ranging from almost white with evenly-scattered spots covering the whole body to animals in which the greater part of the

skin is black and the typical spotting comes only on certain parts. They are much prized as fast-moving plough cattle. The cows are not good milkers, and this may be due to the lack of attention paid to the female animals. In most cases, the cows are extensively used in the plough and are underfed, and hence their milking potentialities seldom have a chance to develop. The average yield of the undeveloped milch cow is 3—6 lbs. a day. The lactation period extends over seven months. The bullocks are particularly in demand for use in *Karah* or earth scoop—a contrivance used for levelling fields. The bulls and bullocks of this type move in short but rapid steps, which is a characteristic feature. The cows of this breed command only one-third of the price of a working bullock, which costs about Rs. 100-150 (1941). Some good *Karah* animals fetch fancy prices. The average female weights 700 to 900 lbs. and the male 800 to 1,000 lbs.

Detailed description of the Dhanni breed and their measurements are given in I. C. A. R. Bulletin No. 47: "Definition and characteristics of Dhanni and Khillari Cattle."

Mr. Ware in the report of the third Cattle Show (1930) at Delhi observed about this breed :

"A very fine breed of medium-sized draught-animals, well-worth preservation in purity. Crossing into this breed should be avoided. The specimens shown were wonderfully even in standard and of high quality."

75. The Hill-type of ancient India : All over India, particularly in the Himalayas and the hills of Baluchistan, a small type of cattle exists which

is so definite in colouring, formation and general characteristics that there seems to be little doubt that it is a very ancient type which has existed in India from pre-historic times. The cattle of this type are very small animals and are usually black or some shade of red varying from almost black to pale dun, while many are parti-coloured. In the majority there is some white on the forehead and the dewlap, while the tip of the tail and the extremities of the limbs may also be white. These little cattle are able to thrive where large, more valuable animals would not survive and are capable of rendering useful service as milch animals as well as for work in the hills and for light ploughing. The cattle of this type are seen as far north as Lundi-Kotal to as far south as the Cape Camorin, also in Baluchistan in the west and Assam in the east, as also in the forest and hilly tracts in various parts of India. They are found in the east and west coastal areas where the cattle are very poor, in the Coorg and Nilgiri hills and in the forest tracts of Rajputana and Central India. Better-developed specimens may be seen near the foot hills which are good working-type animals. If well-fed, these cattle are in fact valuable, very hardy and active work-cattle, with a fair milk-yield for the size. There is no outstanding anatomical peculiarity by which these cattle can be readily distinguished, but the head is smaller in proportion to the body. In the very stunted cattle seen at high levels in the Himalayas, the horns are often quite short, but in the lower altitudes, where better nutriment is available,

they are of fair size. The skin is light on the body and the eyes and the feet are small but of good quality. The cows of this type, where their nutrition is reasonably good, may be fair milkers for their size.

76. (1) **The Siri breed** : These animals are found in the Darjeeling hill tracts and in Sikkim and Bhutan. Bhutan is supposed to be their real home, and it is from Bhutan that the best specimens are brought to Darjeeling. The colours mostly seen are black and white and red and white. The animal carries a thick coat all the year round and this offers considerable protection against the severe cold and heavy rains met with in these hilly tracts.

The general shape of the Siri is massive. Its head is square-cut and small, and is well set. The forehead is wide and flat. The hump is placed well forward and the ears are usually small. The sheath is light ; strong legs and feet are characteristics of the breed. The bullocks are much prized. They can pull loads of 10 to 12 maunds over bad mountainous roads with ease.

Well-fed cows are good milkers giving up to 12 lbs. of milk while the fat content is 5 to 6 per cent. Ordinary cows give 2 to 4 lbs. of milk.

77. (2) **The Lohani breed** : The home of this breed of cattle is the Loralai Agency of Baluchistan. They are also very widely distributed in the tribal areas where they are known as *Acchai* cattle. This breed has potentialities for milk as also for work.

The Lohani is a small animal ; the mature animals are only 40 to 44 inches in height. Their

characteristic colour is red with white patches, although an entire red colour is not uncommon. The bullocks are excellent in the plough and as pack animals, specially in the hilly-area country. They can stand extremes of climate. The cows are said to yield up to 10 lbs. of milk a day.

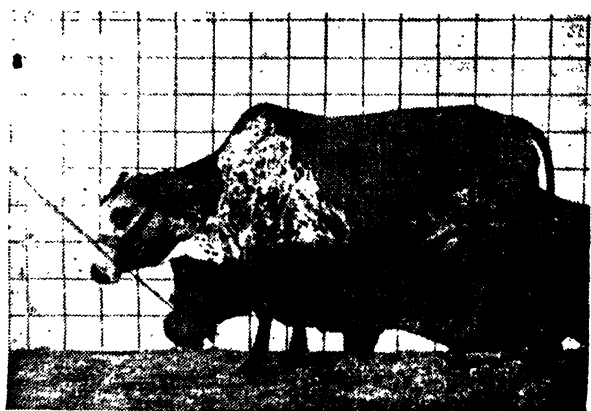


Fig. 22. Lohani Cow.

(Indian J. Vet. Sci. & Anim. Husb., Vol. XII, Part I)

78. Basis of classification of the breeds: The breeds so far catalogued by the Imperial Council of Agricultural Research have been described in the foregoing pages. More breeds are sure to be classified as the work progresses. Due to changes brought about by experiments on breeding, and also due to greater care in observation, the descriptive matter is likely to alter. Yet, inspite of these prospective changes, we have got something to begin with in

the materials already collected by the Imperial Council of Agricultural Research.

The classification adopted above is on the basis of the rough sketch given by Sir Arthur Olver. The basis is that of the place of origin of the breed. It has happened that a breed originally belonging to a certain place got extinct there, but travelling long distances got established without changes in original purity, or more generally with a great deal of change. This being the case, the place of origin of a breed loses significance. For example, let us take the III (A) broad-faced lyre-horned large, grey white type of north India origin. The first name is of the Kankrej breed of Cutch, a place far away from north India, The next name is of the Malvi breed of Central India ; the third is of the Nagore breed of the Jodhpur State ; and the fourth is of the Tharparkar breed of Sind. Therefore, in this enumeration not a name appears at present which is to be found in northern India. What is of moment to the present enquirer of the breeds of cattle is the place where the breeds are at present found, also of what use they are.

79. Classification by present habitat and utility : If the grouping of breeds is made on the basis of areas where they are found, much useful knowledge will be obtained about the various breeds and their interactions on one another.

Then again, another way of grouping the breeds is by their utility. We have only two utility values for cows—one for draught and another for milk. In this country the word “dual purpose” about a breed means

a breed which serves both for draught and for milking. The grouping at present may be thus :

- (1) Draught Breeds of Cattle ;
- (2) Milking Breeds of Cattle ;
- (3) Dual-purpose Breeds of Cattle.

80. Sub-division of draught breeds : Draught breeds may be sub-divided into :

- (a) Fast-trotting breeds ;
- (b) Breeds capable of great endurance ;
- (c) Breeds capable of heavy and slow draught, and so on.

The list may be added to, according to the sub-division, to endless numbers of utility grades. There are breeds amongst draught-cattle which will thrive on scanty food like the Alambadi breed of Salem, North Salem, Coimbatore, or the Khillari breed of Sholapur and Satara in the Marhatta country, whereas the Nagore breed of Jodhpur, reported as the most famous breed of trotting-cattle, is regarded as the rich men's cattle, indicating that they require tender care and rich feeding.

81. Classification on milking basis : Similarly, about milking breeds of cattle. There may be heavy, medium and poor milkers. These qualities again are correlated to the size of the animal. 5 or 6 lbs. of milk per day will be regarded as poor milking quality for a cow weighing 1000 lbs., whereas 5 or 6 lbs. of milk per day for a cow weighing 500 lbs. would be regarded as medium milking capacity for the animals. In this way also sub-divisions would be almost endless.

As for the dual-purpose cow—the heavier among the medium and small cows will form different classes.

Even among them there will be some tending to greater draught quality and some will tend to greater milking capacity, and, therefore, they will require different classification.

82. Types cannot remain constant now : On the top of all these, the types are likely to change fast at the hands of intelligent breeders. So long as much attention was not paid to breeding, a stationary definition or classification might have done. But now that the breeding problem fills a large part of the Government plan of improving cattle, the change of type characters is bound to be fast, and a classification made on the materials available today may be antiquated in course of a few years.

83. Classification by areas : Classification may be made according to the areas in which the different breeds of cattle are bred. Such a classification will convey much weight and will remain more or less stationary for long years to come. But, apart from the geographical area idea, they will be as little helpful as the classification adopted in the foregoing Chapter based on the places of origin of the breeds.

84. Olver's classification serves the purpose : If, however, the present character of the breeds, with their breeding places and capacities are studied, as set forth by Sir Arthur Olver, then a sufficiently clear idea will be obtained as to what to expect from a particular breed, and which is the most suitable area in which it can thrive. Such information will serve the working purpose of the student.

CHAPTER III

THE DUAL-PURPOSE COW

85. Indian cow is traditionally a dual-purpose animal : In India, the cow serves the double purpose of draught and milk provision. The conception of the cow in India is indissolubly connected both with draught and with milking. It has been so from the Rigvedic times and beyond. Shiva rides a bull and Krishna is the son of a *Gope* or *gowala*, a cowherd.

Even in such a land modern theorists and technicians have been trying to pass the cow as principally a draught-animal, and the buffalo as the giver of milk. The thought is pernicious. The field it affects is large and vital, and it is worth while to consider the problem in some detail as to which of the two should be developed as milking animals. Great harm has already been done, and short-sighted zeal for immediate profits has diverted the attention of the people from the cow to the buffalo. A process of neglecting the female of the cow and of fostering the female of the buffalo has gone on for sometime with official approval and favour. Just as jute is the money-crop in Bengal, similarly the buffalo has become the money-animal of some tracts. In times of stress, of political changes or of the exigencies of international trade, jute drives the cultivator into

disaster and ruin while it attracts him for its ready-money-bringing capacity. Similarly, in times of stress, the buffaloes are bound to fail those who are eloquent over them and depend on them. What has been said in the following pages is only of the nature of a preliminary discourse. Much more relevant material will appear where the subject of breeding is considered province by province in **Chapter VI**.

Much has been made of the special Mysore draught breeds like the Amrit Mahal and Hallikar breeds, the females of which were rarely milked. But this is only an example of perversion by a military genius of the type of Tipu Sultan to whom war and military transport meant more than anything else. Yet, even during the time of the Sultan, when the breed was probably being transformed solely for military purpose, the Amrit Mahal was a dual-purpose animal as its very name signifies. *Amrit* is milk and *Mahal* is department. The animals kept in the milk department, evidently for supply of milk to the palace, subsequently were developed solely for draught purposes. The best and finest draught animal being originally a milking animal, it is quite easy to understand that all Indian cows are traditionally dual-purpose animals.

In other countries ploughing is done by the horse or the machine ; and the cow serves the dual purpose of supplying (1) milk and (2) meat. In India the purpose naturally is different, and our dual purpose means milk and draught. Those who were giving shape to the Government policy of cattle-breeding

were guided variously in trying to improve the breeds till the Royal Commission gave a central and executive lead.

The barren character of the Royal Commission Report has been referred to already. It is again brought in here to emphasise the need of the development of the "dual-purpose" cow in India. It has to be pointed out that in this matter the lead from the Royal Commission is of a halting character, and wrong. Here is an extract from its report on the subject :—"Cattle breeding policy in relation to dairying ; and dual-purpose breeds" :

86. Cattle breeding policy : "There is, as has been stated in the preceding paragraph, evidence that in many parts of India the quantity of milk now produced by the cattle, kept by cultivators, is not sufficient to provide their owners with the supply desirable for their own use. In such circumstances, measures to improve the milking qualities of the cattle are very desirable. The type of cow likely to suit the average cultivator would be one capable of rearing a strong calf and of supplying in addition some 1,000 to 1,500 lbs. of milk per lactation for house-hold uses. For cows of this kind there is no doubt much need throughout India. There are some districts in which such animals are already common, there are others where, by selection, they could be produced from the existing breeds, and if produced, might be maintained ; but there are many districts in which cows can with difficulty rear their calves,

where the bullocks are of very poor quality, and where fodder is so scarce that cows capable of rearing good calves and providing any considerable surplus could not be expected to thrive. The improvement of cattle in such conditions is most difficult, and, in these circumstances, it seems to us that, desirable though it be to secure a surplus of milk for the cultivator himself, the first step should be the production of cows which are capable of rearing calves that will make useful draught bullocks."—(P. 224-'25)

It will be obvious on an analysis of the above statement that in those localities where the need for improving the cow both for draught and for milk is most, where the cows can with difficulty rear their calves on account of the scarcity of fodder—in those localities nothing, according to the Royal Commission, need be attempted or can be done ; and if anything is at all to be done then the whole attention should be paid to creating draught-animals and not milk.

The Royal Commission had taken a particular attitude about fodder. In the opinion of the Commission the existing cattle cannot be maintained on the available fodder, and there was no chance of materially improving the fodder-supply in the near future. This being their final view, the Commission had no way to show, but could only point to despair and death.

87. Fodder should be increased, also milk : It has, however, been already shown that fodder-supply can be materially increased. And, working upon the

basis, it follows that attempts should be made particularly in those wretched areas where the cow, for want of fodder, can rarely maintain its calf, to improve the cow by giving her better fodder and make her rear her calf and also supply some milk to the keeper.

Had the Royal Commissioners given a picture of the people of those areas where the cows could with difficulty maintain their calves, it would have become apparent that there was little chance of the men continuing to live as healthy men if the position in both directions were not improved—namely better bullock and more milk.

88. Royal Commission discourages developing dual-purpose cow : Not only does the Royal Commission halt at seeing the need for better rearing of calf and at the need for more milk from the cow, but it goes ahead and discourages the endeavour for developing dual-purpose cows. It makes a choice between more milk and better bullock, and decides in favour of the better bullock, as if the parallel development of both the requirements was impossible. Leaving the position at that, the Commission proceeded to develop the theory: "get your cows to give you bullocks and look to the female buffalo for milk." The inference to be drawn from this suggestion was that it would be more profitable to destroy the females of the cows and the males of the buffaloes. An extract from the Royal Commission where these conclusions are developed is given below :

".....We are of opinion, therefore, that the attempt to provide the dual-purpose cattle, equally suitable

for draught and for milking and *ghee*-production, should only be made in those districts in which the prospects for successful milk-production are markedly better than on the average they now are; and that even in such districts, the question whether it is expedient to develop high milk-production in cows or to resort to buffaloes should always receive careful consideration. The condition of cattle in many parts of the country is, as we have pointed out, deplorable. We are impressed with the difficulties confronting the breeder and we are anxious that dual aims should not complicate his task.—(P. 225)

"We do not criticise the work which has so far been done. The study of the problem by provincial live-stock experts has in most cases, only been begun within the past few years. These experts have been faced everywhere with an insistent demand for more milk production. The natural milking qualities of Indian cattle have been much neglected; the best milking stock in the country has been lamentably abused; very little attention has been paid to their selection by stock-owners; good cows have been extensively purchased for city dairies and slaughtered when their milk dried off. In such circumstances, it was right that efforts should be concentrated on increasing the production of milk; but we do not share the view that dual-purpose breeding should continue to be the sole aim of those who are endeavouring to improve the cattle of India regardless of the tract in which

they are working. More milk is badly wanted in all Indian cities ; but the paramount need of India is the cultivator's bullock ; and in attempting to secure more milk from the fine types of draught-cattle still to be found in many parts of India, there is a real danger that the qualities which in the past have commended them to cultivators may be lost....."—(P. 225)

"In breeding cattle, it must not be forgotten that the evolution of fair milking animals does not solve the problem of urban milk supply. Cheap milk for a dairy business depends essentially on the keeping of productive cows in localities in which suitable fodder can be grown cheaply. This combination of cheap raw material and efficient conversion of fodder into milk must always exist in successful dairying districts.—(P. 226)

89. Dual-purpose argument combated by Royal Commission : "An argument placed before us in support of dual-purpose animals is that the cultivator will feed a good cow if he is given one. We agree that he will try to do so if it brings him a profit, but there is no evidence that for India as a whole there would be a profit. If the cultivator is prepared to treat his good cows and their female calves well, why, it may be asked, are good dairy cattle so scarce and why was it relatively easy to secure good cows formerly in districts in which they are now difficult to purchase ? That this is the case, all those witnesses best qualified to speak on the subject have informed us. We

repeat then that where there is a shortage of fodder, the fodder problem must be faced and solved before any widespread improvement in milk production is a practicable proposition.—(P. 226)

90. Cultivator and milk-seller regarded separate entities : "We agree that there are tracts of country—northern Gujarat, the south-eastern Punjab and parts of the United Provinces, for example—where a dual-purpose breed would meet local requirements, and there are irrigated areas, such as those of the western Punjab and Sind, where the abundance of fodder should enable cultivators to keep heavy milking strains successfully; but, in general, we believe that better progress will be made with live-stock improvement if the needs of the ordinary cultivator and the milk-seller are considered separately. Above everything else, the cultivator wants a strong and active bullock of a breed that can forage for itself and endure hardship when seasons make hardship inevitable. He also wants a cow giving enough milk to rear a good calf and a surplus for his own use, but, in the interest of his young stock, it is undesirable that the ordinary cultivator in tracts where fodder is scarce should be a milk-seller. We do not wish to see the calves of improved breeds dying a 'natural death from starvation' like the male buffaloes of Gujarat; and although the process would not be as speedy for the progeny of the cow as for that of the buffalo, starvation if not death would undoubtedly be the fate of

many calves if a good market existed for fresh milk in districts in which fodder is difficult to provide...."—(P. 226)

91. Royal Commission outlook that of visitors to a museum : The outlook of the Royal Commissioners is the detached out-look of the visitors to a museum. India has some reputed draught breeds of cattle. The Royal Commissioners had an over-anxious regard for seeing that draught quality was not impaired on any account even if it be both to the near and remote interest of the cultivator to do so.

Take, for example, the Hallikar breed. They are a famous breed of draught-cattle. If the cows of this breed are fed better and some milk is obtained for the cultivators' use, where is the cause for anxiety? The Royal Commission had taken it for granted that in all areas except those particularly mentioned, a tendency to improve milking capacity would lead to a deterioration of the draught quality. In the fore-going quotation from the report, the Royal Commissioners went so far as to say that where there was scarcity of fodder breeders should not try to get milk.

92. Royal Commission against breeding more milk in draught types : It leaves the door open to the question, if fodder can be provided, would a Halliker cow be still coaxed or bred to be milked? The answer is definitely 'no' from Sir Arthur Olver upon whom fell the task of giving shape to the recommendations of the Royal Commission on animal husbandry, he being the Animal Husbandry expert to the Imperial Council of Agricultural Research.

His point of view is taken up for discussion. As for the Royal Commissioners, the outlook as has been said, is the detached attitude of observers at a museum—where the observers would think of no change from the excellent type set before them, and will not go to consider the necessity of the change for the good of the breeder himself. All the talk about finding a line where the cultivator can feed his cow enough for rearing a calf and not more for getting some extra milk, is purely imaginary and unpractical. Then again, the distinction made between a cultivator who wants a little milk for his own use from his cow and one who sells the milk is wholly imaginary and ephemeral. The really tender point is the fear of deterioration of the much-prized draught types as a result of the search after milk. (317)

93. Every cow should be dual-purpose cow: It must be conceded that the dual-purpose cow is the only cow for India. Draught is as much necessary as milk, and everything should be done to bring all the breed to the level of dual-purpose within reasonable limits. Sir Arthur Olver laid down that as soon as you put stress on milk you bid good-bye to the excellence of the draught. The concern was for the famous draught breeds, lest they lose their quality. But such a calamity would not happen. If the man who lays down a policy of breeding improvement has a real interest in the welfare of the cultivator, then these show-qualities of breed lose much of their significance.

94. More milk benefits the cultivator : If it be taken as an axiom that whatever is conducive to the benefit of the cultivator should be adopted as the breeding policy, then, if by a little sacrifice of the speed-quality of the draught cattle, the cultivator gains, then that thing should be done. This again is all theoretical. For, I believe that the laying of stress on the milk capacity of all cows of all breeds will not ordinarily affect the draught qualities. On the contrary, draught qualities might increase by more milk coming to the calf out of the increased yield.

Then again, the separation of the categories of milk-seller and milk-producer in the cultivators is altogether unreal. If more milk is produced it will benefit the cultivator, whether he uses it himself or sells it.

In another place the Royal Commission stated :
“...in attempting to secure more milk from the fine types of draught-cattle, still to be found in many parts of India, there is a real danger that qualities which in the past have commended them to cultivators, may be lost....”—(P. 225)

The same thought is repeated by Sir Arthur Olver in an informative article that appeared in the “Agriculture & Live-Stock in India” (1936, July), entitled “Inadequacy of the Dual-Purpose Animal.”

95. Olver on the dual-purpose cow : He asserted therein that it was a physiological impossibility to combine highly specialised activity with really high milking yields. What he meant by “dual purpose” was that combination of the highest speed and

endurance of the bullock with the highest milk yield in its mother cow. This may be a physiological impossibility; but to suppose that the Indian cultivator wants the highest speed when he comes to select a cattle is a mis-statement; "what they demand is a virile active type capable of prolonged work at as fast a pace as is compatible with a load to be hauled." I do not suppose that the Indian cultivator cares for speed and endurance at the sacrifice of everything else. It was not the Indian cultivator's need but the Military Transport Department's that was in his mind, when he (Sir Arthur) said that the demand for the highest speed is compatible with load. Then again, the title of his article was very misleading. By dual-purpose he meant 100 percent milk yield. But ordinarily 'dual-purpose', applied to an animal, would mean an animal of which the male was a good draught-animal and the female a good milker.

96. Olver's definition of dual-purpose : For such an animal Sir Arthur Olver has got a different name—"general utility" animal like the Gir which gives good milk and provides good draught. He says that this is possible. So, apart from the misleading title of the article and the misconception that the Indian bullock purchaser wants 100 per cent draught efficiency at the sacrifice of milking capacity, what he put forth in the article is commendable and acceptable.

There need be no quarrel about the use of the word "dual-purpose". Sir Arthur Olver uses it in a

specialised sense of his own ; but this carries with it the misconception started by the Royal Commission that “in attempting to get more milk from the draught cattle the qualities which have in the past commended them to the cultivator may be lost”. He, in the course of his article, appeared to support this statement when he said, “throughout India it is generally considered, from the experience of ages, that *high* milk yield is not compatible with a capacity for fast work.” But looking closely into the wording it is found that while the Royal Commission deprecated the attempt to have “more milk” out of the draught breed, Sir Arthur said that ‘*high*’ milk yield was incompatible with a capacity for fast work.” This does not shut out the possibility of having *moderate* milk yield with high draught capacity.

97. **High or moderate milk yield :** A breed which gives moderate milk with high speed or a breed which gives moderate speed with high milk yield, is regarded by Sir Arthur as a “general utility” animal and not a dual-purpose animal. We have no quarrel with the definition. What he calls “general utility animal” is regarded generally as the dual-purpose animal. But his object is to keep the two lines separate—breed either for speed or for milk. If you mix the two objects you cannot breed true to a type.

98. **General utility and dual-purpose :** To produce and maintain high-grade stock which will breed true, it is essential to breed and feed constantly for the very best of a particular type. On the other hand, it is only too easy to breed

mediocre general utility animals, not of the highest class in either direction, which could never be relied upon to breed true to any factor. Usually too many of the type are produced even while breeding for a special type, and those who want dairy-cum-work cattle would be better able to obtain them if high-grade bulls of the two well-developed types were available.

“Nevertheless, there are very useful general utility breeds, e.g. the Gir breed of Kathiawar and western India, individual cows of which are capable of reasonably high yields which could no doubt be developed. The bullocks are powerful though slow workers and incidentally have a greater capacity for the production of good breed than any other Indian breed.”

“Such breeds have a definite value and with the replacement of the fast-trotting bullock by motor transport it is probable they will become more popular...”—(*Agriculture & Live-Stock in India, July, 1936*).

So far Sir Arthur Olver takes a rationalistic stand. If all the cattle of India were like the Girs and Sahiwals and Harianas, who will regret? The Gir is a heavy milker and a good draught animal, as Sir Arthur admits. The milking capacity of some of the best is 7,000 lbs. to 8,000 lbs. in 300 days, and the bullocks are known to be very good at rapid road transport and at the plough. Even if we take the highest milk-yielding type of India, the Sahiwal, we find that while the Sahiwal cow has worked up to the standard of

9,000 lbs. per lactation in well-managed cases, the bullock is not a pitiable animal. The bullock is good at slow heavy work.

99. What is lost in speed is gained in strength : What it has *lost in speed* it has *gained in strength of draught*, so that more soil can be turned up under the plough with a slower draught Sahiwal, thereby tending to equalise with the quicker and higher draught. But we have not yet seen what careful selected breeding can do. In the experiments carried on with the pedigree Sahiwal herd at Pusa, Mr. Wynne Sayer has shown that he has been able to bring about distinct skeletal changes in the Sahiwal bull giving it greater potency value, and also in the cow a better udder capable of better management. The same thought devoted to putting a little more draught-quality into the bullock by a process of selective breeding might accomplish the desired change in the capacity of the bullock, making the Sahiwal an animal good for milk and equally good for draught—a quality which has been theoretically urged by Sir Arthur Olver as “a physiological impossibility.”

100. Olver's premises— wrong : Sir Arthur Olver talked of the temperament of the Indian cultivator, and based his conclusion upon this premise. After concluding that with the problem of quick transport transferred to motors, it was expected that powerful, slow bullocks would be more popular, he went on to opine :

“...But the ordinary Indian cultivator who must get his land ploughed as quickly as possible after the

commencement of the rains, and who has to cart his produce long distances to market, is likely for sometime to come to continue to demand quick workers. Further, so long as he is prepared to pay comparatively highly for them, as he does at present, breeders in the natural grazing areas are certain to breed for this market."

101. The cultivator's fancy for speed : Out of ignorance many things might certainly happen. But, if it is to the interest of the cultivator to sacrifice some speed for some more milk, then that change has to be introduced. But, it is not really the Indian cultivator that matters ; it is the military temperament and partiality for speed in Sir Arthur the soldier, that caused this aberration. He was not satisfied even with the Haryana, as he was not with the Gir. No, he could get no satisfaction temperamentally, till he saw two distinct classes only in India, either the best draught type or the best milk type. The half-way ones or the 50 : 50 ones, as he said, were no good to him.

He expressed his regret at the failure of the Gir becoming a Sahiwal :

"Inherent in this breed (Gir) there is undoubtedly a high capacity for milk-production, and with intensive breeding purely for milk, there is every indication that selected strains could rapidly be developed into a highly efficient milch breed, as has happened in the case of the Sahiwal. So long, however, as it is bred for two distinct purposes, the breed is likely to remain merely a

useful breed, capable of giving good service to the cultivator but unable to hold its own in competitive commercial dairying or in the market for high-grade draught-cattle."

And there was regret also for the Haryana for the same reason :

"In the Haryana of the Delhi-Rohtak-Gurgaon tract, we have another example of a breed in the making of which milk yield has undoubtedly received considerable attention, probably ever since the days of the Moghul Emperors, when large quantities of milk were no doubt required in this area. In more recent times the milking capacity of this breed has again attracted the special attention of the breeders because of the high prices which good milch cows fetch for milk production in Calcutta or Bombay, owing to the increasing difficulty of obtaining good cows nearer at hand. But the bullocks of this dairy type, though useful for work on the land, cannot compare with the powerful Hissar type which are constantly seen on the roads and in the Delhi city..."

102. Speed in ox—a military need : Here again the regret was of the military man which had come to the top, that looked for speed and not to the interest of the cultivator. But as a scientific man Sir Arthur gave away the whole show when he admitted that what was lost in speed in draught-bullocks of the milking types was gained in the volume of work done at a given period of time, as when he said :

"...Moreover, though there are slow breeds which have been intensely bred for milk, such as the Sahiwal and the Red Karachi, which do in fact produce powerful bullocks, whose lack of speed can to some extent be compensated for by the use of larger implements."

That being so, we need not fight shy of what Sir Arthur Olver called "general utility" animals. There is no doubt that the word "dual purpose" as used by the Royal Commission meant what he called "general utility" animals.

103. Experts differ : Dr. Norman C. Wright who came on a commission to report on the "Development of the Cattle and Dairy Industries of India," (1937), does not fully accept the views held by the Royal Commission on the "dual-purpose" cow :

".. This indicates the extreme urgency of taking immediate steps to extend the facilities for selecting and improving indigenous milking strains of Indian cattle..."

"I should, perhaps, add that I do not consider that such efforts should be limited to those breeds which are recognised as predominantly milking types. Table 31 shows that improvement can be looked for in the milking capacity of most breeds other than those of purely draught type, such as the Amrit Mahal and the Hissar breeds. Even the latter breed is found to possess strains of special milking potentialities..."—(P. 69)

All this had to be discussed for meeting the wrong lead which Sir Arthur Olver had given. His opinions

counted, and for a time it was his voice that guided the policy regarding animal husbandry of the Government of India. This has much practical bearing on the proposition of generally increasing the milk yield of all the cows all over India. This increase of milk-yield is a desirable thing and a practicable thing.

104. Dual-purpose and general utility are one : For those who work for improvement in a breed the problem should be to find out ways and means for providing nutritious and balanced diet for the herd. Once this is assured the next step would be to try to coax the cow to give more milk. The famous breeds of draught-cattle need not stand on their fame and starve the cultivator. There also, efforts should be made to make the cow give more milk. More milk from the cow will mean better rearing of the calf and a healthier calf and, therefore better bulls and bullocks on the one hand and better cows on the other hand. This will mean all-round benefit to the cultivator and assurance of his welfare.

105. The need of "dual-purpose" for milk : It would not be out of place here to mention that India, owning the largest percentage of cattle in the world, produces the least quantity of milk per head of population. It is estimated that the production of milk per head of population is about 6 ounces per day. This is an all-India average. Along the east coast, in the region of Central India and the areas near about it, the milk-consumption per capita is much lower than the average for all-India. To be more exact, the more fortunate Provinces with regard

to *per capita* milk production are Sind, the Punjab and the U. P., with Bihar closely following. The Provinces poor in milk are Bengal, Bombay, Orissa, Assam. The following is the list schedule :

106. Milk consumption table for provinces :

			Ounces of milk per head, of population per day.
Sind	...	...	22·0
Punjab	...	...	19·7
U. P.	...	...	7·8
Bihar	...	...	6·1
Madras	...	...	3·6
Hyderabad	..	...	3·6
Mysore	...	...	3·6
Bombay	...	...	3·3
Bengal	...	...	2·9
Orissa	...	...	2·5
Central Province	...	...	1·8
Assam	...	...	1·2

107. The work ahead : What an amount of uphill work is to be done if all the Provinces are to be like Sind or the Punjab in matters of milk production and consumption ! And there is no doubt that with organised national effort, it is quite possible to increase the milk production to what it should be.

The necessary fodder can be provided. The breeds are already there. Even the worst of the non-descript cattle will yield to better treatment and provide much larger quantities of milk per lactation, and at the same time be converted from the wretched

animals they are today to the "general utility" or the "dual purpose" type, as we may call it.

In spite of the tenderness for the famous draught types, shown by the Royal Commission, by Sir Arthur Olver and Sir Norman C. Wright, it is pleasing to note that things proceeded naturally towards more milk supply on account of the better care taken of the cow as a result of the new movement giving impetus to cattle breeding. We find Lord Erskine in his opening speech at the second meeting of the Animal Husbandry Wing of the Board of Agriculture and Animal Husbandry held at Madras (Dec., 1936) observing as under :

"In providing for the production of working cattle, needed for ordinary agricultural operations, the necessity for at the same time for producing more milk and reducing the large number of unprofitable cattle maintained at present should, therefore, be not overlooked. In Madras a very good example is provided by the famous Ongole Breed of how with suitable feeding and management these requirements can to a large extent be met by the rearing of high-grade cattle under semi-stall-fed conditions, and it is of great interest that breeders of such an essentially working-type cattle, as the Kangayam and the Amrit Mahal, in the breeding of which attention has in the past been almost exclusively confined to working capacity, are now paying more attention to milk production."

We find that even the almost sacred Amrit Mahal cow is being paid attention to for yielding milk, and

in the Ajjampur breeding station she is recorded to have given over 2,100 lbs. of milk in a lactation of 342 days. Therefore, we remain confirmed in the opinion that in spite of the wrong lead given, things are shaping in a natural way for more milk production with better care for the cow. We also find that typical draught breeds like the Kangayam and the Kankrej are yielding over 4,000 lbs. to 5,000 lbs. of milk per lactation in the Madras and Surat Government Farms. Specially reassuring is the statement of Captain Macguckin made at the first meeting of the Animal Husbandry Wing (1933) at New Delhi, that he considered that "by good feeding and management from their earliest days the milk-yield of cattle could be almost doubled".

The earlier writings of Sir Arthur Olver about the "dual purpose" cow have already been referred to. But on the eve of his retirement he contributed an important article to the "Agriculture and Live-Stock in India" (September, 1938) entitled "Systematic improvement of Live-Stock in India" in which he showed a complete change of view after his mature experience in India.

"Such a system, however, postulates the breeding of a reasonable amount of milk into the recognised working breeds, and I am sure from my own observations and from the observations of experienced breeders of Indian cattle that, up to milk yields considerably beyond what would be necessary, this can be done without damage to the stock as work-animals."

108. Change in Government policy : The Seven Tracts Recommendations : At the instance of Lord Linlithgow an enquiry was held in 1937 to find out conditions of the production and consumption of milk in typical breeding tracts of India in order to determine the future cattle-breeding policy of the Government of India. This report was considered by the Standing Cattle-breeding Committee of the Council and by the Advisory Board. This official body has among other recommendations laid down : "The breeding policy should be to maintain and raise the milking capacity of the females of draught breeds within reasonable limits in so far as this can be done without risking damage to the type".

And, if even the star draught-breed of India of the Mysore type, the Amrit Mahal breed, can be made to yield 1,500 lbs. and more in a lactation, the problem of the "dual purpose" cow is solved, and it has now to be accepted that the Government policy is in favour of creating "dual-purpose" cows all over India.

The official bar to the attempt at putting more milk into the cow of the draught breeds, as it was attempted to be imposed by the Royal Commission, seems to be lifted. In the 1942 Report of I.C.A.R. it is found that the Council has undertaken to develop the milking capacity of the Kangayam cattle.

In the Government farm at Hosur, the Kangayam cows were giving a good yield of milk. In a herd of 102 cows, 61 averaged an yield 4.8 lbs. Two cows gave 4,000 lbs. and 4 cows gave 3000 lbs. 6 gave over 2,500 lbs. each. (226, 246, 252)

CHAPTER IV

COW VS. BUFFALO *

109. **The Royal Commission and the buffalo :** The Royal Commission straight away discouraged the attempts at more milk production by the development of the "dual purpose" cow, because the Commissioners had formed the idea that the buffalo was a better milking animal although we know today that it is not so. Holding this erroneous view they thought of looking to the cow for draught purpose only, and for milk to the buffalo. This was a wrong lead given by the Commission. Although the higher claims of the buffalo as a milker has been found to be incorrect, yet the mischief continues, and the official mind is still after the buffalo for meeting the milk requirements of India.

The Royal Commission said :

"...We are of opinion, therefore, that the attempt to provide dual purpose cattle, equally suitable for draught and for milking and *ghee* production, should only be made in those districts in which the prospects for successful milk production are markedly better than, on the average, they now are ; and that, even in such districts, the question whether it is expedient to develop high milk production in cows or to resort to *buffaloes* should always receive careful consideration..."—(P. 225)

* For full reference of this chapter refer to paras under 127.

The Commission then elaborated the point thus :

"...The view has been expressed that, since the buffalo is a rival of the cow, the best policy for the cattle breeder would be to *concentrate effort on the improvement of ordinary cattle* in as much as it is wasteful to retain two species of domestic animal where one of them might supply the demand for both milk and draught. We have already stated that, in our opinion, the time is far off when the cow will supersede the buffalo. There are over 14 million she-buffaloes in British India alone, and to replace them it would be necessary to provide at least twice the number of good dual purpose cows. It is evident that both in the economy of the ordinary village and on the holdings of those engaged on dairying, room should be found for both species. There should, in our view, be no relaxation in the efforts to improve the buffalo..."—(P. 227)

110. Keeping two species of animals wasteful :

The premises put before the Royal Commission as the view of some that "it is wasteful to retain two species of domestic animals where one might supply the demand for both milk and draught" are unchallengeable. The Royal Commission had in its own way distorted the premises to suit the conclusions favourite with them. The proposition was to "concentrate effort on the improvement of ordinary cattle". This was distorted by the Royal Commission to mean "to replace the buffalo." And then the Commission went on to say that since replacement was not

possible, therefore attention should be paid to improving the buffalo.

It is a curious piece of argument. The Commission, in other words, recommended breeding the male of the cow and the female of the buffalo ; and since the people will not slaughter, the Commission by inference gave sanction to the proposition that the males of the buffalo "must die a natural death" from starvation, and the female calves of the cow must carry on a miserable starving existence in comparison with her rival the buffalo, who the Commission understood, was better cared for and looked after by the cultivator.

111. Stress on improving the cow : This is all narrow thinking in support of a conclusion already arrived at. If it is in the economic interests of the cultivators to have one animal for both draught and milk, then the policy should be to lay stress on the development of the cow and let the buffalo be. It is no question of replacing the buffalo. If one animal is to be relied upon for serving the dual purpose of draught and milk, then the cow is that animal and the buffalo is not. Therefore, even from the economic point of view it is necessary that the cow should be developed for both draught and milk. When the proper stress is laid on the cow, then gradually the buffalo will yield her present place ; she will be favoured less and less, and it may be that in course of time she will largely go back to the jungle from which she came. There are no dearth of wild buffaloes in the forests even now. In other words, buffalo-breeding will cease to be fostered.

A wrong lead was given by the Royal Commission, although it had been put on record that buffaloes were less amenable to improvement.

112. Buffalo less responsive to improvement :
 "The small amount of experience gained by agricultural departments seems to suggest that the buffalo is less responsive to selective methods than the cow," observed the Royal Commission. Here is a table showing how the two animals have responded to attempts at improvement between 1913 and 1925.

113. Cow vs. buffalo yield in Government farms :

The following Table gives the yield of cows and buffaloes in Government Military Farms :

Animal Giving	Cows.		Buffaloes.	
	1912-13 No.	1924-25 No.	1912-13 No.	1924-25 No.
10,000 lbs. milk & over	...	1	...	...
3,000 to 10,000 lbs.	...	34	1	...
3,000 to 8,000 lbs.	9	116	12	25
1,000 to 6,000 lbs.	84	438	117	354
3,000 to 4,000 lbs.	834	685	778	605
Under 2,000 lbs.	1,257	233	859	124
	<hr/> 2,184	<hr/> 1,507	<hr/> 1,767	<hr/> 1,108

The number of cows yielding over 2,000 lbs. has risen during the short period of 12 years from 1·3 to 20·5 per cent and the number of buffaloes from 1·6 to 10·8 per cent.

114. Comparative incompetence of the buffalo :
 These figures should at once have led to the finding of the relative place of the two animals in the matter

of selective breeding. The Royal Commission got over the comparative incompetence of the buffalo and found satisfaction in the fact that the ordinary cultivators is ignorant of his own interests and "that cultivators in many districts much appreciate attention to buffalo-breeding."

But what should a Government Department do? Should it let the cultivator go on with buffalo-rearing because he is ignorant or teach the cultivator the better way and ask him to pay greater attention to the cow which is admittedly a more responsive animal, and in the end, therefore, is sure to beat the buffalo economically?

The wrong lead has continued to operate pretty long and created great mischief. Even such an independent and keen observer as Dr. Wright has taken the line of argument from the Royal Commission, in the matter of the buffalo.

115. Wright at one with Royal Commission on the buffalo: He observed (1037): "The Royal Commission rightly stressed the importance of the she-buffaloes as the chief milk-producing stock in India. Thus they wrote that 'it is the number of she-buffaloes not the number of cows that has to be taken into account when seeking an index of the milk production of a province. ... Wherever an important market for *ghee* exists, it is the she-buffalo which mainly supplies it.....' It is, indeed, not difficult to explain the popularity of the she-buffalo. Her average milk yield is markedly higher than that of the ordinary village cow,

the butter fat content of her milk is also higher than that of cows' milk, while she appears to possess a remarkable ability to convert coarse fodders into milk. Considering the poor nature of the fodder normally available under village conditions and the hard conditions under which the animals have to live, the hardiness of the she-buffalo is a most valuable asset to the cultivator."—(P. 71)

116. Statistical interpretation of the popularity of the buffalo: "The popularity of the buffalo is reflected in the census statistics. It will be seen that while the number of cows has scarcely altered, the number of buffaloes has risen by 13 per cent. The importance of the buffalo is also seen in Table 33 which shows the number of cows and she-buffaloes, their relative milk yields and the extent to which they contribute to the total milk production. Numerically cows exceed she-buffaloes in every Province but the Punjab. The she-buffalo makes up for this deficiency, however, by her higher milk yield, with the consequence that in five out of the ten Provinces she actually produces more than half the total milk production. It is significant that the main *ghee*-producing areas of India are situated in these Provinces. In British India she-buffaloes provide 47·5 percent of the total milk supply ; in India as a whole (though the figures are incomplete) they provide nearly 45 per cent."—(*Ibid*)

117. Relative importance of cow and buffalo in relation to milk production :

TABLE—5.

	Bovine population.		Average lactation yield.	Total milk production in thousand maunds.		Proportion of milk contributed by buffalo.
	Breeding cows and buffaloes over 3 years old, kept for breeding or milk production.			Cows.	Buffaloes.	
	Cows.	Buffaloes.	Cows.	Buffaloes.	Cows.	Buffaloes.
Assam.	1,305,188	112,781	170	430	2,771	628
Bengal.	7,673,067	256,669	420	960	40,283	3,080
Bihar &						
Orissa	5,792,528	1,625,792	440	1,770	31,913	37,166
Bombay.	1,796,896	1,153,869	500	885	11,135	12,035
C. P.	3,216,893	830,084	500	700	19,745	7,222
Madras.	4,280,661	2,395,870	430	775	23,112	23,175
N. W. F. P.	206,994	137,648	800	1,200	2,069	2,164
Punjab.	2,549,778	2,873,692	1,400	2,160	44,745	78,040
Sind.	761,107	339,573	1,000	1,500	9,513	6,350
U. P.	5,726,249	4,060,877	800	1,000	57,262	50,760

118. **She-buffalo better cared for :** "The value placed on his she-buffaloes by the cultivator is also apparent from their better-nourished appearance in comparison with the country cows and from the fact that even under village conditions their milk yields are exceptionally high. It is questionable whether under present conditions of feeding and management the dairy cow could displace the buffalo: as has been aptly stated, 'when prices of fodder are low the she-buffalo can compete with any breed in butter production and beat the ordinary Indian cow in production of both milk and butter. This is the main reason why the villager prefers the buffalo to the cow notwithstanding the fact that he has to pay a higher price for the buffalo'. Whether the same argument would hold if the cultivation of better types of fodder crops were to be widely employed is doubtful. The Military Dairy Farms have found that under good conditions of feeding and management the ordinary Sahiwal can produce as much milk as the buffalo, while high milking strains of the breed will produce over half as much again. On the other hand, it should be pointed out that no serious attempts have been made to improve the milk yields of buffaloes by selection and breeding from high-yielding strains—a subject which is worthy of extensive study. In the meantime, it is certain that for many years the she-buffalo will more than hold her own in competition with the cow as the premier milk-producing animal of India."— (P. 71-'2)

119. Nourished buffalo and starving cow compared : All that can be said in favour of encouraging the breeding of buffalo has been said. The various items concerned in this sweeping observation on the importance of the buffalo should be carefully examined. Dr. Wright says that the value placed upon the she-buffalo by the cultivator is apparent from her better-nourished appearance. Now, it is the record of a fact that the she-buffalo is better cared for than the cow. How can there be a fair comparison between an unnourished and neglected cow and a better-nourished, well-cared-for buffalo in the matter of milk yield ? The cultivator has hitherto cared less for the cow and more for the buffalo. Scientific breeders now tell us that the cow is more amenable to improvement than the buffalo.

120. The cow should be the milking animal : The cultivator should, therefore, be taught that by caring equally for the cow he could get equal milk-yield, and on the whole, profit more from the male calves of the cow, whereas the male of the buffalo was a waste to him. This is the right lead. It is not proper to sit upon the ignorance or mere aptitude of the cultivator, and allow him to be deprived of a better condition of things in the future. Today it has been said that half the milk-yield of the country comes from the buffalo. But what do we want tomorrow ? If it is uneconomical and wrong, we should then formulate a better policy and guide the cultivators.

Dr. Wright sailed from Bombay, after completing his investigation on the 25th March, 1937. In July, 1937,

there appeared in the "Agriculture & Live-stock in India" an article entitled "Live-Stock Improvement in India"—by Col. Sir Arthur Olver which cleared the position. He questioned the advisability of watering down buffalo milk to the level of the butter fat of the cow in evaluating the milk.

"...Where abundance of coarse fodder is available and where the production of *ghee* is a major consideration, or where liquid milk is produced for sale usually by unscrupulous and uncontrolled hawkers—the she-buffalo is at present commonly preferred. But investigation has shown that pure-bred cows of certain Indian breeds of cattle can in a comparatively few years be improved by proper feeding and management to a point where they can compete successfully with the buffalo in economy of milk or butter-fat production. In view, therefore, of the greater general utility of cows as compared with buffaloes, in that they produce better working animals as well as milk, and of the important fact that cows' milk is a much better food, particularly for children than buffaloes' milk watered down to the same level of butter-fat, the question whether cows should not be bred and as well-fed and maintained as are she-buffaloes, is one which merits careful study."

The superiority of the buffalo as a milch-animal in so far as it depends upon its milk being passed off as cow milk after dilution with water to the cow's butter-fat content, by unscrupulous and uncontrolled hawkers, is no superiority.

121. **Olver clears mistaken idea about milk values :** Again, Sir Arthur Olver in his article "The Inadequacy of the dual-purpose animal" (Agriculture & Live-Stock in India, July, 1936) observed :

"It is true that in many parts of India the buffalo is the milch-animal, but this is largely because it is easier for the milk vendor to water buffaloes' milk and escape detection and because buffaloes are better able to stand the very unsatisfactory conditions under which cows are usually maintained for city milk-production. Moreover, owing to mistaken ideas of food values of the different constituents of milk, the consuming public demands so-called rich milk, i.e., rich in butter-fat and pays little attention to the proteins and mineral salts, which in reality are the more valuable parts of milk for human nutrition. The feeding-value of standard cows' milk, i.e., milk with 3.6 percent butter-fat is in fact far higher than that of an equal amount of cream, and it would be of great advantage to the Indian people if more attention were paid to the mineral salts and protein, which are contained in whole milk and most of which remains in skimmed or separated milk than to butter-fat, which in a diet, such as most Indian diets, which consist largely of starch and sugar, is not so much needed."

It is, therefore, quite clear that the so-called superiority of the she-buffalo as a milch-animal is a superiority measured with an weighted scale. By herself, devoid of these helps of fraudulent dealers who pass her milk as cow milk, devoid of help by

the ignorance which puts no value on the protein and mineral contents of the milk, devoid of help by the cruelty that allows the male calf to be starved out, and thereby allows more milk to be drained out, the she-buffalo cannot stand against the cow on equal terms. Besides, it has been proved that the buffalo is a less responsive animal than the cow as regards breed improvement.

122. Cost of milk & butter fat from cow & buffalo :

About cheapness or otherwise the following figures are published in the Milk Marketing Report of 1940.

TABLE—6.

Cost of Milk Production of some Government Farms.

	Sindhi cows Pies	Ordinary Sahiwal cows Pies	Ferozepur Sahiwal cows Pies	Half- bred cows Pies	Murrah buffalo Pies
<i>(a) Cost per pound of milk</i>					
Food cost during lactation	4.48	4.45	3.88	3.55	5.68
Food cost during dry period	1.42	1.61	1.01	0.69	1.95
Depreciation of stock	2.01	1.83	1.33	1.42	2.20
Labour cost (exclusive of supervision)	1.51	1.29	0.94	0.83	1.29
Total—	9.42	9.18	7.16	6.49	11.12
<i>(b) Cost per pound in annas and pies</i>					
of butter fat	15-8.4	15-3.6	12-11.6	13-6.3	13-3.1
No. of animals studied	84	179	51	213	294
Average lactation yield (lb.)	3,050	3,800	6,000	6,000	3,100

It will be found that the milk from Ferozepur Sahiwal is 7·16 pies per pound as against buffalo milk at 11·12 pies per pound. Then again, fat made from Ferozepur Sahiwal is annas 12/11·6 pies as against annas 13/3·1 pies from buffaloes. Both ways, the Ferozepur Sahiwal milk and product had proved itself to be considerably cheaper than buffalo product. In this connection Sir Arthur Olver had noticed :

“It may be pointed out, however, that this note is the result of an investigation financed by the Imperial Council of Agricultural Research and relates to the data maintained in Government Military Dairy Farms under the control of the Imperial Dairy expert. Sindhi and ordinary Sahiwal refer to Indian cattle which have had no advantage of systematic breeding over any appreciable period. The Ferozepur herd is specially built up and has over 20 years systematic selection and breeding. Buffaloes are of the Murrah breed.”

The economic efficiency of the Ferozepur Sahiwal for the production of milk and butter-fat is evident from the above Table. These figures related to 1932 when the investigation was carried out. Milk-yields of Sahiwals and other cows have appreciably gone up since. Striking examples have been obtained in other farms, for example, the Imperial Agricultural Research Institute, Pusa, and the Agricultural College Dairy, Lyallpur, where systematic breeding of the Sahiwal has been taken up.

When the fullest possible light is thrown on the cow vs. buffalo question, it will appear that it is

morally and economically sound to concentrate on the cow and let the buffaloes be, so long as they are not naturally replaced by cows.

123. Buffalo brings women private income : That the buffalo is bred in most places, contrary to the true interests of the cultivator, is found from a passage in the Madras Government Publication—"Live-stock of Southern India" (1936) by Captain R. W. Littlewood, Deputy Director of Agriculture, Live-Stock, Madras. Writing about the present deterioration which is coming over the Ongole breed on account of shortage of pasture and fodder land the author said :

The Ongole cow "...generally conceives for the first time from 4 to 5 years of age instead of within the 3rd year, and calves about every two years or so after this. She yields about 7 to 8 lbs. of milk over a lactation of 250 days and generally becomes barren after 4 or 5 calvings. Most of this is due to poor feeding. The ryot is aware of this fault and says that circumstances do not permit him to feed the female stock, but yet at the same time he feeds his she-buffalo well. The woman of the house looks after the buffalo and she makes a small income out of this by selling *ghee* and curds. In fact, the buffalo is unnecessary if the ryot would feed his cow with the food which the buffalo consumes; it would improve in condition, breed more regularly and the milk flow would increase in many cases. The cow would provide sufficient milk for the ryot's domestic use and also enough to feed the calf."—(P. 30)

124. **Gandhiji on cows vs. buffaloes :** The Go-Seva Sangh, an All-India Institution at Wardha was founded on the 30th September, 1940, by Gandhiji. One of the objects is to foster the breeding of cows as against buffalo-breeding. In his opening speech, Gandhiji observed :

“We have a weakness. In a way it is common to all mankind, but it is a special trait of Indian character that we readily take to things which are easy to get and give up things that are difficult to accomplish. In khadi, village industries and everywhere people seek ease, cheapness and convenience. People relish buffalo's milk because it is sweet and cheap.”

“Even from the Vedic times we have been singing the glories of the cow and not of the buffalo. Had the cow not been given this status it would have been extinct, and along with it the buffalo also, long ago. I have seen the comparative figures of both the animals in India. Both are numerous. But neither flourishes. The herdsman keeps the cow and the buffalo only so long as it pays to do so and sells it off to the butcher as soon as it ceases to pay. To save their lives the humanitarians buy them up but with the money so gained the butcher purchases other cows and buffaloes. Thus a few cows may be rescued, but the destruction of the cow's progeny goes on. The correct remedy, therefore, is to forget the cow that has been sold and spend our money in improving the breed of the cow, increasing its value and teaching the cow-keepers their duty.”

125. By saving the cow the buffalo is saved :
“Let nobody fear that if every one eschews its milk and *ghee* the buffalo is bound to perish. As I have said above it is hardly possible. But even if it were possible there is no harm. The buffalo will cease to be a domestic animal and will become wild. The fact is that if there is any animal which can survive it is the cow only. Along with the cow the buffalo will be automatically saved, because the milk of both is useful to us. But if people go on following these haphazard ways, as they have hitherto been doing, in utter disregard of scientific methods, the cow no less than the buffalo will be destroyed as has happened to many other things in our country. Our ignorance has been the greatest contributing factor to this state of affairs. We shall be able to know and observe our duty towards animals only by an intelligent study of the science of cow-keeping. Fundamentally by protecting the cow we realise our duty towards all living beings. But, having reduced cow service to a farce we have forgotten our real religion.
“India possesses a fourth of the world’s cattle population. But the cattle of this country are in a worse condition than even its men and women.
“The servant of the cow may use the cow’s milk and its products exclusively. He may not take goat’s milk. I take it out of helplessness. But a member of the Go-Seva Sangha should use only cow’s milk and its products and leather of dead and not slaughtered cows and bullocks.”

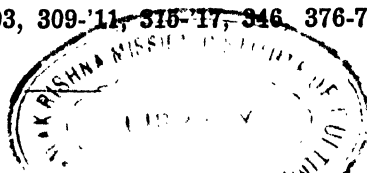
126. Buffalo milk incomparably inferior : Recent investigations have shown that from the dietetic stand-point buffalo milk is incomparably inferior to cow's milk. The dietetic value of butter-fat is due to its vitamine A content. Fats from vegetable oils do not contain vitamine A. As between cow-butter-fat and buffalo-butter-fat, the cow-fat is over ten times richer in vitamine A than buffalo-fat. This is dealt with more fully in Para 520. Comparative merits of the cow and the buffalo are also discussed in Paras 133, 275-'78, 335, 338, 339, 372

127. Density of cows and she-buffaloes and of the human population in British India :

TABLE-7.

Province.	Per square mile		
	No. of Cows.	No. of Buffaloes.	Human Population.
United Provinces ...	60·1	42·6	508·2
Punjab. ...	26·3	29·7	243·7
Bihar & Orissa ...	59·9	18·7	453·6
Madras ...	30·0	16·8	328·5
Bombay. ...	23·2	14·9	232·9
N. W. F. Province ...	15·3	10·1	179·3
Central Provinces			
& Berar ...	32·1	8·3	155·2
Sind. ...	16·4	7·3	83·8
Bengal. ...	91·5	3·4	646·4
Assam. ...	23·7	2·0	156·7

—(261-'62, 274-'79, 303, 309-'11, 315-'17, 346, 376-79, 519-'24, 1090, 1136)



CHAPTER V

BREEDING AND GENETICS

128. The problem of cattle-breeding stated : After the Royal Commission, and more particularly after the commencement of the viceroyalty of Lord Linlithgow, great official importance was given to cattle-breeding, and the Viceroy inaugurated a scheme of presenting bulls to various localities for grading up the local breeds.

Numerous enquiries were carried out by the different Provincial Agricultural and Veterinary Departments to tackle the problem of cattle improvement from all the points of view, such as :

- (1) Provision of fodder-crop and grazing ;
- (2) Combating contagious and other infectious diseases ;
- (3) Provision of better bulls ;
- (4) Elimination of Scrub and undesirable bulls from selected areas ;
- (5) Educative propaganda about the importance of the above ;
- (6) Researches for prevention of diseases, for finding out the nutritive values of grasses and fodders and also of their mineral contents ;
- (7) Keeping of authentic records in the form of Herd Books and Milk Registers ;

(8) Expansion of veterinary service and provision of stockmen for the villages ;

(9) The fixation of breed characteristics, etc. etc.

129. Sir Arthur Olver—a lover of cattle : The impetus that followed the Royal Commission has been many-sided. The establishment of the Imperial Council of Agricultural Research by itself was a great measure for giving shape to the manifold problems and requirements of cattle-breeding. The appointment of an Animal Husbandry expert of Sir Arthur Olver's reputation in 1930 was an event of great moment. Sir Arthur had a brilliant and varied career in the Royal Army Veterinary Corps. He worked in South Africa under Sir Arnold Theiler. He was also in the Egyptian Army as its Principal Veterinary officer. He also served in the U.S.A. He had thus varied experience, particularly of tropical cattle in Egypt and in other parts of Africa and in Central America. He put in only 8 years of service in India, retiring in 1938. During these eight years he contributed very largely to the improvement of the cattle in India. He was a successful practical idealist and never lost sight of the goal before him. He believed that the Indian cattle had the best milk and draught strains in them. Finding of fault with the proverbial blemishes of the Indian cultivator—his poverty, his ignorance, his lack of initiative, his suspicious character, his superstition etc.,—has been the burden of talk of many an Indian and European veterinarian. But Sir Arthur was not of that type. He brought an unprejudiced, scientific mind to his study of the problems. He argued that

even England was backward in Animal-Husbandry legislation. He argued that what 200 years of breeding by the rich and educated land-owning class of England did for cattle improvement and what a benevolent Government in Holland did by a century of work, what American States with all their efficiency and funds were accomplishing, could not be shaped out in India without systematic effort, and it was the unified and sustained effort on the part on the Central and Provincial Governments that was needed for bringing about cattle improvement in India. He knew his work and like a true scientific and practical man he could lay down precise conditions, the fulfilment of which was bound to make the cultivators prosperous in cattle wealth. Such a man need not indulge in cheap sneers at Indian character. He seemed to understand the terrible difficulties under which the Indian cultivator worked, and pressed on the Government to make the way smooth for him for bettering his live-stock.

He was successful in inducing the Government to open a new Nutrition Research section at the Veterinary Institute, Izatnagar. He caused Disease Investigation officers to be appointed in the Provinces who in contact with the Centre could be of immense use in controlling diseases in the Provinces.

He fought for more financial help for the Veterinary Department, which, as he brought out, only received a disproportionately low share of the funds for the Agricultural Department of which the Veterinary Department was a part. Like a true champion of

the cattle he fought with his colleagues for allotment of proportional expenses for crop-growing and the live-stock industries, the two arms of agriculture. His colleagues occasionally could not be pleased with his insistent demand for making Animal Husbandry finances more reasonable. He fought against this attitude of theirs so long as he was in charge of the Animal Husbandry work in India. He brought into being the Delhi Cattle Show and made it a success. He fixed the breed characteristics of many Indian breeds after original investigation. These are some tangible points in the brief but brilliant career of Sir Arthur Olver. But "the intangible results of his eight years' work are more important", as was observed by the editor of the "Agriculture & Live-Stock."

130. Cattle problem acquires importance: Cattle breeding, although very recently taken up scientifically by the Government of India, has advanced by rapid strides. Previously the individual efforts of the various Military Dairy Farms or researches in the various Institutes were all that was done for the improvement of the cattle. There was no long-distance policy, and the whole subject suffered. Systematic work has now enabled pointed attention to be drawn to the real needs of the cattle-breeding industry. Sir Arthur's endeavours have thrown much light on the question of the cattle position of India and on scientific cattle-breeding.

One mistaken belief about the improvement of cross-breeding with European bulls has been knocked

out, though it still lingers. This has to be considered as leading on to the much larger problem of the genetics of the cow. The British cows are, some of them, great milkers. It was easy to try to improve the milking quality of the Indian cow by importing bulls from Britain. (35)

131. Cross-breeding experiments : By intermixture of the Zebu blood of India with the European blood, an immediate effect was noticed in the increase of milk yield in the first generation of crossing. But the cross-bred cattle, produced in this way, rapidly deteriorated. Besides the deterioration of milk yield, the crosses show remarkable susceptibility to infectious diseases like rinderpest. The cows and bulls of Britain, imported into India, fall easy victims to the infectious diseases of the tropics and succumb to them. The seeker after large milk-production may find the first cross a paying thing. It is for its milk-yield that some admixture of European with Indian blood had been and is still going on, particularly in the Government Military Dairy Farms. But this creates great mischief. For, the mixed-blooded crosses afterwards become a drag upon the already deteriorated cattle in India.

Mr. J. Edwards in an article on milk production in the tropics observes :

“The importation of European breeds into the tropics is usually a failure and not satisfactory as a general breeding policy. The first generation from imported animals may be satisfactory, but subsequent generations are usually unable to maintain the

constitution necessary to thrive satisfactorily in a tropical environment.” (35, 168-’69)

132. European breed—a failure in the tropics :

“For tropical countries like India, the solution of the problem of providing satisfactory milch-cattle for ordinary conditions of feeding and management, lies in the improvement of indigenous stock. It is true that the indigenous cattle of India are usually of heterogenous origin and their improvement is likely to be somewhat protracted but the building up of a strain of improved stock always takes time ; e.g., the European breeds have taken two centuries to attain their present level of production” (*Agriculture & Live-Stock in India, January, 1935* ; P. 64). (35)

133. Foreign breeds unnecessary : Sir Arthur

Olver, on the eve of his retirement, contributed an article entitled “The Systematic Improvement of Live-Stock in India.” In this article dealing with the subject he wrote as follows under the heading ; “Foreign Breeds Unnecessary”.

“The improvement of live-stock and of cattle in particular, is indeed a matter of great social as well as economic importance and urgency in India, and it is necessary to emphasise that it has now been amply shown that it is unnecessary and unsound as a general policy to attempt to introduce European breeds of cattle into India. Systematic investigation, carried out by the Animal Husbandry Bureau of the Imperial Council of Agricultural Research, has shown that by careful selection and proper feeding and management, herds of pure

Indian dairy cattle have already been produced within 25 years which can more than hold their own in India with European cattle and with the best Indian buffaloes, in economy of milk and butter-fat production (Karthia, 1934). Already, they exceed the average milk-yield of commercial dairy herds in Europe and America, and there is every evidence that these results are likely to be steadily improved upon for years to come. While, it has already been demonstrated that even with the best of care and under the best possible conditions, cattle of European origin always tend to degenerate in India. "Nor should it be forgotten that if a policy of using imported cattle were adopted, it would be necessary to keep up year after year a huge supply of pedigree sires, purchased abroad at very high prices, the cost of which would generally be prohibitive. Without most careful and expert breeding control the use of foreign cattle for stud purposes is moreover dangerous. Indeed, it has already done incalculable harm by destroying valuable pure-bred herds of Indian cattle by unscientific mating." (*Agriculture & Live-Stock in India, September, 1938.*) (35)

134. Crosses should not propagate : It is only in the decade 1920-'30 that the importations of foreign sires were made in large numbers. In the Military Dairy Farms in the Northern Circle comprising the Punjab, the N. W. F. Province and Baluchistan, the experiments on cross-breeding were extensively carried out. The foreign sires were all Friesian sires.

The matter of the utility of these cross-breeds was discussed in the first meeting of the Animal Husbandry Wing. Messrs Kerr (Bengal) Datar Singh (Punjab) Bruen (Bombay) and others were of the opinion that the unwanted cows from cross-bred animals spoiled the indigenous breeds. In fact, in one resolution the military people were requested not to dispose of their cross-bred stock without making them sterile.

Opinion has since been definite that the cross-bred cows from foreign sires, though they may show an immediate higher yield of milk in the first generation, soon deteriorate and that the cross-bred males are wholly unsuitable for use for draught purpose and, therefore, of no use to the cultivator. (35)

135. Breeding requires knowledge of genetics : To the lay man nothing is simpler for improving the breed of cattle than crossing with a better breed. Many fall into the mistake of thinking that cross-breeding is mere mathematical combination of two sets of qualities. If A and B are combined in mating, the progeny will show a combination of half the qualities of A and half of B. But nothing can be further from the truth. Genetics or the science of breeding is not mathematics. In order that the student of Animal Husbandry may not fall into the popular error, a little discussion of the elementary principles of genetics, as applied to cattle improvement, is necessary. This subject is dealt with next. (35, 169)

136. Cow slaughter put forth as a step : In Europe they made considerable progress in improving the cattle. The eating of beef has undoubtedly eased

the problem of disposing of the inferior, uneconomic and old cows in their struggle for the improvement of the breed. In India, we are blindly asked to do also the same. Whenever the topic of improving the condition of the cattle in India comes up the Hindu is blamed for his repugnance to cow-slaughter. His religion is blamed for it. It is not for a moment asked why the Hindu developed this cult of regarding the cow with reverence. (25)

137. **Why the Hindus abhor cow slaughter :** It has become a tenet of Hinduism to revere the cow and look upon her as sacred. The Hindus had a past when they also slaughtered cows for meat. But later on Hinduism took the turn for abhorrence of cow-slaughter and regarding it as a sin. The Hindus learnt to believe in the oneness of all life—human, animal and plant life. The cow was the animal nearest to man in work and service. By protecting and revering the cow the Hindu satisfied his hunger for loving all living beings. The cow was to him an emblem, a symbol of all animals. This is the sentiment that actuated the Hindu to frame his attitude towards the cow. It is wrong to evaluate him on the standard of the European, where such a sentiment, although current enough in individuals, has not grown to the proportion it did in India, so as to be laid at the very foundation of the social structure. (25)

138. **Hindu sentiment worthy of being fostered :** This Hindu sentiment is not condemnable ; on the contrary, it is worthy of being fostered. In fact, the absence of this feeling in the present generation of the

Hindus in the matter of treatment to the cows needs condemnation. That the cows are starved and neglected is a misfortune which the Hindus should more keenly feel. They should find means to save the cow from starvation and neglect. But this is a counsel of perfection. It is no use preaching religious duties to a starving man. The Hindu is starving and his cow is starving. Well-wishers should point a way to stop this double starvation.

Before foreign rule had upset almost all that was best in Indian life, Indians did not starve and the cows were not what they are today, and certainly they were not neglected. Otherwise, the fine breeds that still now exist could not have been developed. (25)

139. Slaughter will not end the impasse : The economist asks the Indian cultivator to get rid of the surplus, useless and old stock by slaughter. But that will not end the economic impasse. Supposing that the present surplus is disposed of by sale, slaughter or disease, the next generations will soon recoup the loss and fill the country with useless stock. The remedy, therefore, lies not in disposing of the present surplus but in acquiring the habit of slaughtering the cows regularly for meat. The Hindus must have to be beef-eaters in order to satisfy our economists. (25)

140. Beef-eating—not the best solution : Beef-eating is, however, not the best solution. There are better solutions. The cow has to be fed, and it will cease to become a drag on the slender means of the cultivator. If the manures, the dung and the urine

no less, are valuated at their proper manurial values, the useless, old and decrepit animals will be found to be useful manure-producers, so greatly needed for fertilising the fields for receiving greater return from the land.

Even in America today, slaughter of the useless or the unprofitable units in the herd, is not looked upon as the first choice. Improvement is the first thing.

“It is said that one-third of the dairy cows owned on American farms are being carried at a loss, that one-third produce just enough to pay their way, and that practically all the net profits come from the other third. If this is true, as it doubtless is, there is a great waste of feed and labour in caring for low-producing cows. It would not be practical, however, to eliminate two-thirds of our dairy cows, because this would bring a great shortage of dairy products in this country (America). Must we then, in the interests of the consumer, continue to milk 8,000,000 dairy cows at a loss and another 8,000,000 at little profit? No, there is another way out and that is through dairy herd improvement.—(P. 190-'91—*Dairy Enterprises*—McDowell & Field.) (25)

141. Improvement through better breeding : Desire for herd improvement as a matter of community interest gave rise to the Hindu custom of dedicating Brahmani bulls during the *sradh*. A noble custom but now misused by dedicating not choice animals but any scrub calf. The prevalent custom of today is a vestige of what once was a commendable act of merit.

A description of the way in which bulls were dedicated only perhaps a few years ago in South India is given by Capt. Littlewood in his book "Live-Stock of Southern India". (195-'98, 271, 282, 286, 288, 293-'98, 306, 350, 486)

142. Brahmani bulls were to improve the breed :
"Brahmani bulls are bulls which have been dedicated to the temple. A well-to-do influential man dies in his village and his relatives wish to commemorate his name ; therefore they dedicate a bull in his memory. In former years great care was exercised in the selection of this bull ; a committee of leading cattle breeders and ryots was appointed and they paid very special attention to each of the 32 points which they considered a good breeding-bull should possess. A number of good promising bull calves were brought to the village immediately after the death of the person, and the committee discussed the good and bad points of each animal and eventually selected the best. The selection was very rigid and no one questioned it, once it was made ; the price was also fixed by the committee and this was always accepted. The young bull was branded at the funeral ceremony of the deceased by the priest and then it was set free to roam about wherever it liked. The animal was allowed to enter any field of growing crop, and it was considered a sin to drive it away. Should it enter the farmstead the ryot usually fed it until it departed. At the present time, the selection of the bull has developed into a mere formality and has led to a lot of

quarreling ; no importance is attached to the selection. Due to this, and the high price demanded for a good bull calf, the relatives of the deceased now usually select a bull calf from the deceased's own herd or purchase a cheap animal and dedicate it. It is evident that this practice is growing. In some places the ryots drive off the breeding bulls from their growing crops and consider them both destructive and a nuisance. Owing to the high price of food-stuffs the donors of these bulls are criticised instead of praised, and they generally have to take charge of and stall-feed them during the time the crops are on the land."—(P. 16-17)

This shows that the South Indian donor still feels some responsibility for the Brahmani bull let loose. In many places outside South India the donor is lost sight of and the bull roams about and is driven from field to field or receives ghastly cuts from unkind hands during the crop-growing season and in some places the Municipalities publicly yoke them to their scavenging carts.

That this dedication of selected bull calves for communal use was a noble custom is beyond doubt. Instead of decrying it, the remedy lies in castrating the useless Brahmani bulls and inspiring the would-be donors to realize their duties to the community for selecting the very best bull-calf of the locality. (282-'83, 305-'06, 350, 483)

143. Co-operative attitude in bull dedication to be fostered : There is more in the institution of the Brahmani bull than is apparent. This system makes

the villager community-minded at least as regards cattle-breeding. "This co-operative attitude towards stud animals can be further encouraged and it is believed can be directed to secure results which will change the present trend of live-stock degeneration to one of live-stock improvement." (From the note for the 3rd Animal Husbandry Wing meeting from Mr. Parr, Dy. Director of Agriculture, U. P.)

If the Indian cultivator is to exist, the Indian bull, bullock and cow, must be improved. The cattle, instead of being a drag as they are, may, under altered circumstances, become one of the greatest sources of wealth of India, no less than they are in Holland. The question of improving the breeds of cattle is a vital one. A movement is going on in official India for the improvement of the cattle. A general idea of the cattle improvement work going on in the different Provinces is worth having for every one interested in the subject. But, before this subject is taken up, it is necessary to have some knowledge of what constitutes breeding improvement and of some features of the problem of genetics connected with it. (480-'86)

144. Breeding practice of the past in India : Cattle-breeders throughout the ages have sought to improve the milking and draught qualities of India by selection. The cow, as we find her today, is not what she was in pre-historic times. The cow was once a wild animal. Man has domesticated her and by constant care and wise lead has been able to make her an indispensable adjunct of civilised life. The cow and man have been bound together by innumerable

ties throughout the ages. Men have profited by the cow and have ever attempted to make her more and more useful to man. Indians have shown her ever-increasing kindness even as an expression of gratitude to her. (11, 187, 369-'71)

145. Mendel's law : By selecting better and better types and by stressing the favourable features in mating animals, it has been found possible to create different and superior types while the breeds varied with localities. It has been achieved principally through a regulated use of the laws of inheritance of functions. What the wise breeders have done through the ages by observation and by gathering experience is found to be practically based upon certain laws of inheritance discovered much later. We are indebted to Johann Gregor Mendel, an Austrian monk, for the discovery of the laws of inheritance, now known as Mendel's Law.

146. Classic experiment with yellow & green peas : Mendel experimented with garden peas, and by a close study of the method of transmission of simple characters, such as colour and size, discovered the principles embodied in the law known after him. Although he experimented with plant breeding, his law applies equally well to animal life.

By crossing yellow and green peas he produced the hybrid yellow strain. The colours are characters of the plants as much as their appearance and taste etc. are. The law of inheritance discovered is the same again for the various characteristics that constitute an individual of which colour is one. Mendel at first

crossed yellow and green peas and obtained hybrid yellow peas. When these hybrid yellows were planted, the resulting peas were green and yellow in the ratio of 1 to 3. In the next generation all these green peas reproduced green, but two-thirds of the yellow of the second generation behaved in the same way as the first yellow hybrids, giving 1 to 3 green and yellow peas, while the remaining third of the yellows reproduced yellow.

From these observed facts the law of inheritance was traced. In order to be able to understand the operations of the law of inheritance some knowledge of the structure of organisms is necessary.

147. The structure of plant and animal cells :

All parts of the plant or animal body are made up of cells. These are as bricks of which a house is built. Most cells contain a small structure called nucleus. This nucleus is the centre of life and activity of the cells. Cells divide and reproduce for growth. In this division the nucleus also gets divided.

When a cell nucleus is divided it is found to contain microscopic bodies now named chromosomes. There is a distinction between the body cells of an animal and the reproductive cells. In the body cells the chromosomes are found in pairs and there is a definite number of chromosome for each different species of living things.

148. The chromomeres and chromosomes :

The chromosomes are developed from dye-absorbing or chromatin granules. The individual units of grains of these chromatins are called chromomeres, and there

are many thousands of chromomeres in a cell. A definite grouping of these *chromomeres* constitute each *chromosome*. These chromomeres are the carriers of all inherited *characteristics*. The unit of inheritance is called a *gene*. The *genes* by interaction of the chemical substances in the cells control the development of characters.

149. Chromosomes in reproductive cells : It had been mentioned that the body cells and the reproductive cells are different. In the mechanism of inheritance, it is the reproductive or the germ cells that are concerned. One of these germs from each parent unite to form the individual. In the formation of the mature germ cells the number of chromosomes is reduced to half so that two germ-halves with half chromosome of body cell in each, may combine to form a cell with the same number of chromosomes as in the original body cells of the parents. Therefore, in the new creature half the character chromosomes come from each parent or the individual takes up half the character of each of the parents and becomes a composite character. The chromosomes giving character are so various that it is left to chance as to which of the characters of each parent will be inherited by the off-spring.

150. Pure yellow, hybrid yellow and pure green peas : Taking the colour of peas to be a character, what happens in uniting green peas to produce individual peas is indicated in the following Chart. Here the original yellow and green peas combine to give a variety of *hybrid yellow* pea.

In the next generation this hybrid yellow pea gives rise to

- (a) One pure yellow off-spring.
- (b) One pure green off-spring.
- (c) Two Hybrid yellow off-spring.

Therefore, the remarkable fact comes out that by sowing only one sort of hybrid yellow pea, 3 classes of peas are produced in different plants, being *pure yellow*, *pure green* and *hybrid yellow*. It is also found that for every one pure yellow pea there are two hybrid yellows and one pure green pea plant.

151 Chart to illustrate Mendel's law :

Mendel's work was done with peas, but the principles he established apply to animals as well as to plants. Where there is only one pair of chromosomes in the body cells of each parent e.g. yellow and green, we get in

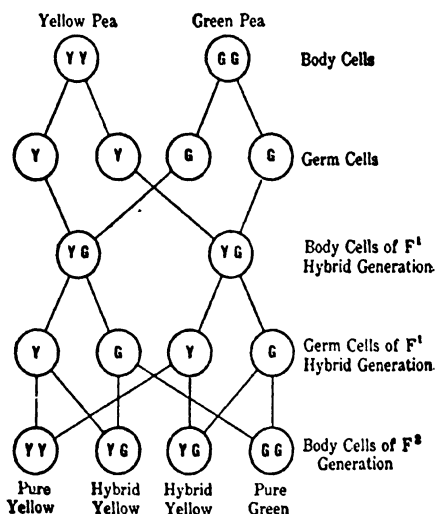


Fig. 23.
Chart to illustrate Mendel's Law.
(Dairy Cattle & Milk Production)

the second generation 3 different varieties by the combination of the characteristics. Where the number

of chromosomes in the cells are numerous, the characteristics in the following generations by combination of two individuals in reproduction will give a surprisingly varied number of characteristics. And the reproduced individual may have any of the hundred different characters that might form out of the combination of the two characters having numerous chromosomes.

152. Number of chromosomes in a cell : A definite number of chromosomes develop in the cells of each particular species of organism. For corn the number is 20, for wheat 16, for man 48, for cow 46. In most insects it is between 8 and 18. In a species of thread-worm of the horse the number is 2.

The chromosomes are usually present in pairs ; and some pairs are long, others medium and yet others are short. Of the two chromosomes of a certain length in a body cell, one is derived from the sperm of the father and the other from the ovum or from the mother.

153. Zygote or reproductive cell : We shall now try to understand how lots of different combinations may come out by this process of division of the chromosome cell into Zygote or reproductive cells, and their combination with a similar number of the other sex to form a new individual.

It has been worked out that an individual, having 5 pairs of 10 chromosomes, produces 5 chromosomes in one reproduction cell and 5 in another reproduction cell. These are called Zygotes. In sexual reproduction the five half-pair chromosomes of the female combine

with the five half-pair chromomes of the male, producing in the new individual 5-paired chromosomes one of which comes from the mother and the other from the father.

154. Five Zygotes give 1,024 combinations : The 5 half-pairs in a Zygote in the process of reducing division may make 32 possible combinations, and of these 32 combinations any one may couple with the 32 combinations of the other sex, thus giving a possibility of 1,024 different types of individuals. It will be many times more in the case of the cow. And there is no wonder why any two children born of the same parents are not exactly alike (except in the case of twins).

Of the characters conveyed by the chromosome some dominate over others and others get dominated over in the same pair. The one dominated over is called "recessive" and the dominating one is called "dominant". In the case of chromosome pair Y G yellow and green in the above Chart, it will be seen that the resulting colour is a shade of yellow. Because yellow is a dominating and green is a recessive colour. Therefore, in the case of hybrid yellow fruit or animal, when they mate, the resulting off-springs will have the following characters as per above Chart, (Fig. 23) :

YY YG YG GG

155. YG to YG gives : 4 varieties of which two are hybrid yellow and one pure yellow and the other pure green. In the combination YG if Y were recessive and the green dominant the resulting colour

would have been hybrid green but as a matter of fact green is recessive and the result is hybrid yellow. In the above set of body-cells YY is called *homo-zygous* and so also GG is *homo-zygous*, whereas YG is hetero-zygous i.e. having different chromosomes in the same cell. In a combination of black and red colour, homo-zygous black mated to homo-zygous black will give only black off-spring. Homo-zygous black mated to hetero-zygous black will give all blacks, black being the dominant colour. But of the issues 50 per cent will be homo-zygous and 50 per cent hetero-zygous.

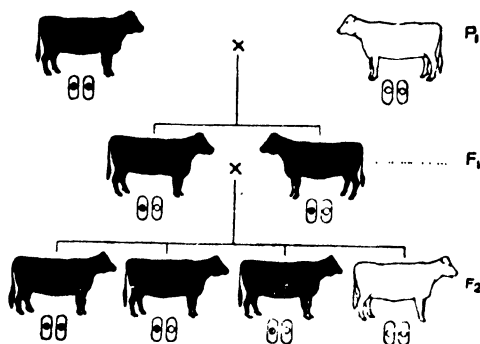


Fig. 24.

Homo & Heterozygous Characteristic.

Black × Red,

(Red is necessarily white in the diagram)

(Black's Veterinary Dictionary)

156. Homo and hetero-zygous characteristics : Hetero-zygous black mated to hetero-zygous red will give 50 per cent hetero-zygous blacks and 50 per cent reds. Red mated to red will give all reds. But when

two blacks mate they can give a red calf when a hetero-zygous black mates another hetero-zygous black.

In other words, out of two black parents three black and one red off-spring will result. Where red colour is disliked and black is the fashionable colour it will be a calamity.

157. Purity in breed : When we say purity in breed we mean the individuals are capable of propagating the true type. In the above case, it is not pure. Purity can, therefore, have an exact meaning. Most characters in animal inheritance depend upon a number of units for their complete development. This is true of the production capacity of milk and also of the fat-content of the milk in the cow.

Each individual possesses all the normal characters of the race to which it belongs. The characters may or may not be evident. In the higher races the characters are so numerous that all of them cannot develop in a single individual. An individual will transmit to its off-spring things which are not apparent in its constitution. For example, milk production is a function of the female but it is transmitted both by the cow and the bull.

158. Reversion to type : Recessive characters may be carried for generations without being evident on account of the dominants. By a mating of individuals having the same recessive germ-plasms, the recessive character may come to the surface. This is known as reversion to type. This is the proper explanation why in the Mehwat cattle of white

or grey colour recessive red appears, indicating the Gir admixture (*Vide Mehwati breed, Para 53*).

As we have "dominants" in chromosomes, similarly we have the word "prepotent" to indicate the dominating character of the individual which it can impress upon its progeny. A cow or a bull with prepotency for milking will impress its high milking quality upon its progeny, however they may be mated, although their off-springs may lose prepotency and revert to mediocrity.

159. Selection in breeding : In animal breeding, it is impossible to mate individuals which are absolutely identical, and therefore, variation is found to occur. Judicious selection has been of the best aid to the breeders in the improvement of live-stock. By selection, the best ones are retained for propagation and the undesirable ones are rejected both in the male and in the female. The general increase in milk production in any specialised dairy breed can be attributed to the practice of selection. Environment, feeding and handling also, of course, count. For permanent progress there must be consistent selection and mating of those which have demonstrated that they carry the desired combination of germinal factors. Here again, the influence not only of its parents but of its ancestors also works upon the individual. It has to be known that the ancestors contribute the less progressively to the character, the more they are removed.

160. Relative importance of ancestors : A law operates governing the influence of ancestors on the

character of the individual. It has been found that an individual ancestor in the first generation contributes 25 per cent of the character, in the second generation 6·25 per cent of the character, in the third generation 1·56 per cent, and in the fourth generation 0·39 per cent.

The importance of pedigree or the line of inheritance has to be judged in this light. If an individual is found to have a very prominent and desirable ancestor third place removed, it has to be put down that the influence of that ancestor on the character of the present individual is only 1·56 per cent. The immediate parents count most.

161. Character of one parent may dominate : About inheritance it is true that male and female contribute equally to the total heritage of the off-spring. But it does not mean that the parents are equal or that the influence of one parent may not dominate over the influence of the other. On the contrary, the more prepotent of the parents will dominate over the less prepotent. It has also to be remembered that the off-spring, though taking the character of the more prepotent parent, may not transmit that character undiminished to the next generation. The germinal make-up may be mixed or hetero-zygous, and many of the desirable qualities may then fail to pass on to the next generation.

162. Place of sire and dam in the herd : The place of the sire and the dam in a herd has to be seen from another angle. In a herd each dam contributes its share of character to its off-spring, but the bull,

common for the herd, contributes its character to all the off-springs of the herd. Herein comes the supreme importance of the bull in the herd.

163. In-breeding : It is the mating of closely-related individuals such as brother to sister, sire to daughter or son to dam. When such close-related individuals are mated, the primary effect is to intensify or fix hereditary qualities and thereby bring about prepotency for certain characters. In the early establishment of any breed for the fixation of a type, in-breeding is very valuable. The germinal make-up becomes relatively pure as generations pass by with such in-breeding. The transmission of the character of the parent to the off-spring then becomes almost certain. And it is by this means that the best breeds of cattle in Europe have been developed. But it has its dangers too. The same mechanism that fixes the good points will fix the bad points also, and may lead to disaster. Then again, close in-breeding decreases fertility, vigour and longevity. If fertility is diminished the breed ceases to be of value. In-breeding is a valuable instrument in the hands of expert breeders, but is a very dangerous weapon if indiscriminately used. In-breeding accompanied by selection is used to great advantage. But it must be emphasised that in-breeding in the hands of any one but an expert breeder is dangerous. (501-'02)

164. Line-breeding : The mating of animals related to a lesser degree than described in in-breeding is called line-breeding. Where the common ancestry runs from 25 to 50 per cent, it is called line-breeding.

This has most of the advantages of in-breeding with much less of the concurrent dangers of in-breeding.

165. Out-crossing : The mating of entirely unrelated individuals of the same breed is called out-crossing. By out-crossing with a superior bull a highly successful result may be accomplished, but no breeder will continually out-cross. Once a coveted result is obtained, the breeder will attempt to fix it up in the herd by line-breeding. This is what the most renowned breeders do.

166. Cross-breeding : The development of distinct and famous breeds of dairy cattle in India, such as the Amrit Mahals, the Girs, the Sindhis, the Harianas or the Sahiwals, is the result of a long-continued process of selection of individuals showing characters sought for by the breeder. By this process the desired character becomes fixed and results in purifying the germ-plasm which ensures a degree of certainty in the transmission of the desired traits when individuals of the same breed are mated. By crossing distinctly different breeds this transmission of factors is interfered with. The result is not a mixture of the characters of the two. That it cannot be so, we have already seen. The new off-spring will show an entirely new combination of factors and units which may result in the loss of most of the valuable traits of each parent. On the contrary, the off-spring of a cross may prove to be a very desirable product. But crossing is certainly working with an unknown quantity. It may so happen that in the first cross the result is encouraging, as had happened in India in

crossing the well-known Indian milking breeds with the Holstein Friesian bulls. In the first cross a factor comes in which in genetics is called "hybrid vigour".

167. Hybrid vigour : Hybrid vigour is clearly demonstrated by increase in size, and in the earlier attainment of sexual maturity. It is shown by the first cross-bred generation out of the mating of two dissimilar pure-bred parent stock. It is a case of hetero-zygosis, and in the off-spring this hetero-zygosis may, to a very considerable degree, pool the desirable characters exhibited by the parents. This may be fixed by subsequent in-breeding and line-breeding. But the results are uncertain. In India, as the result of crossing Indian pure-breds with European pure-breds, the first half-breds showed remarkable milking qualities. But this could not be preserved by all sorts of combination of increasing the blood of either of the parents or by in-breeding. The result has been, as has been pointed out, a costly failure. This crossing of the *Zebu* blood of the tropical oxen with the blood of the European *Taurus* oxen was started with much hope in India. But the crossing has proved to be a failure.

168. Crossing experiment for Anglo-Indian breed at Hosur : Sir Arthur Olver in his preface to the "Live-stock of Southern India" (1936) by Capt. R. W. Littlewood wrote :

"The section dealing with the systematic attempt which has been made at the Hosur Farm, to establish a breed of Anglo-Indian cattle, is of particular interest since it shows that after years of careful work, under very favourable conditions,

the result of such cross-breeding has on the whole been disappointing." (35, 135)

169. Olver on cross-breeding: "This is in accordance with world-wide experience of European cattle within a wide tropical belt encircling the globe. Within this zone pure European cattle have, as a rule, failed to hold their own, even when, as in the southern States of the United States of America, the disease conditions, which were previously a severe limiting factor, had been brought under control. Moreover, there is abundant evidence in India that in the hands of inexperienced breeders, irreparable damage can be done to the existing herds of pure-bred stock by the unscientific use of foreign breeds. On the other hand, the results achieved by the Military Dairy Farms show that within a reasonably short period of time, it is possible, with scientific breeding control and management, to build up from indigenous breeds of Indian milch cattle, high-yielding strains which are quite able to compare favourably with European or cross-bred cattle, and it is very clear that this is the proper policy to pursue under existing conditions." (35, 131, 135)

170. Grading up: Next to cross-breeding is the process of grading-up. Cross-breeding is reserved for use in mating two pure-bred individuals of different breeds. If the pure-bred male of a well-tried breed is mated with a female of a non-descript type, the process is called grading-up. This process of mating a non-descript with a pure-bred gives birth to an

off-spring with hybrid vigour which can be maintained greatly. Grading up has begun in India, and the results have so far been satisfactory, where fore-thought has been exercised in selecting the type of a pure-bred male for mating. There are dangers here too of indiscriminate and short-sighted work. If, for example, a Sahiwal bull is mated with a Bengal non-descript cow, the off-spring partaking of the heavy build of the parent will be quite unsuitable for the soft clay soil of the rice fields of Bengal. So far as is known, this is reported to have taken place in certain localities. By discreet use of a proper breed of bull much can be done by way of grading up the non-descripts distributed so largely all over India.

171. Inheritance and milk-yield : The permanence of a milk production standard of a cow from lactation to lactation practically depends mostly on inheritance. The size of the cow is partly responsible for the milk yield, and size is inherited. Both sire and dam influence the characters of the off-spring. This is true about milk production also. If high-yield was dominant over low milk-yield, then the improvement of the milking quality would have been simple. As a matter of fact, high milk-yield is only partly or incompletely dominant to low milk-yield. The factor for high milk-yield can, however, be transmitted by the male. It is, therefore, that a bull having a high milk strain in it and prepotent for transmitting it to the off-spring is such a desirable individual in a dairy. Milk-yielding is a very complex factor and cannot be predicated truly from ancestry as black or white

colour can be predicted. In fact, the record of an off-spring may be such in the matter of milk-yield of a cow as to completely deny her breeding. Environment and handling also influence milk-yield, and the best breeds may not show excellent results if the management be wrong.

172. Pedigree and milk-yield : In order that the expected performance of an animal may be judged in advance, the keeping of pedigree books and registration systems have been introduced. Bulls and cows giving a certain minimum performance are liable to be registered. Their pedigrees are noted and their off-springs and their lactating capacity also are noted when they come to milk. The progeny of the parents are, therefore, registered in advance, and the method has been adopted as helpful in providing a market for good off-springs. But mere pedigree register is likely to mislead. We have known that an animal with a good pedigree may turn out to be untrue to its immediate ancestors.

173. Pedigreed and proven bull : It is for this reason that the progeny-test has received more and more attention and is worthy of encouragement. When one buys a bull by looking at its pedigree, he buys an unknown animal which may turn out to be good, bad or indifferent to the best performances for the type or breed. It is, therefore, desired that a *proven bull* or *progeny-tested* bull is the animal to be secured.

Progeny-tested or *proven bull* means that the milk yield of his daughters has been found to be satisfactory. Such a bull is bound to give satisfaction

both for the advancement of the type or for the grading-up. But, the difficulty is one of obtaining such a bull, specially in India. Here there is already great dearth of good bulls, and a proven bull is not likely to be obtained ordinarily. Another point is the difficulty created by the late maturity of animals here to wait for a progeny test. If a bull is used for the first time at 3 years of age, the off-spring cast out by it may come to deliver a calf at least $4\frac{1}{2}$ years after that. So that by the time the daughter of the bull comes to milk, the age of the bull will be $7\frac{1}{2}$ years. And the bull is expected to effectively serve up to 12 years or less. So that by the time a bull passes a progeny test it has only a few years of effective service before it. It is for this reason that till early maturity for the bull and the female calves is obtained, the problem of obtaining progeny-tested or a proven bull must remain an unsolved proposition. The breeder will have to depend upon the pedigree and upon his general experience in deciding about the expected performance from a bull.

In breeding, the influence of environment should also be kept in mind. The best bull may fail to create superior progeny in a bad environment. This applies also to the cows.

CHAPTER VI

BREEDING IN THE PROVINCES OF INDIA.

174. Breeding in the provinces : It is necessary for understanding the present position of cow-keeping in India that a brief account of the breeds, the breeding and feeding methods and practices of the breeders be drawn up. Unfortunately not much material is available on this subject. But what is available is of great interest. Of the Provinces, the Punjab is the most go-ahead in animal husbandry. Its Veterinary Department seems to be the best organised. The Province is the home of the Sahiwal, the Haryana and the Dhanni breeds, and it is well worth-while knowing what is happening in that Province and about the Government machinery set up for cattle improvement and the control of diseases there.

Madras and Bombay are other go-ahead Provinces. Madras is the home of the famous draught-breeds of the Amrit Mahal and its allied breeds, the Hallikar, Kangayam and Bargur. It is also the home of the famous Ongole milch breed. In Madras the old traditions of cattle-breeding still exist, and there are still castes of professional breeders who have not entirely forgotten their old breeding practices which brought the southern breeds of draught and milch cattle their all-India fame. The Bombay Presidency is the home

of some of the best milk-breeds, and it enjoys a great importance today on account of its rich capital city. The United Provinces Government today is wide-awake to the importance of improving the cattle wealth of the cultivators, and has some of the most interesting and useful institutions of India. In the Province is located the Government farm for breeding the Harianas on an extensive acreage. It possesses its particular system of supplying good stud-bulls to the cultivators at the least Government expense, and above all it has the position of pride in having the Central Institute of Research at Izatnagar. Sind, a small, newly-created Province, is great in its high milking and powerful draught-breeds. The Red Sindhi cow has secured a place of esteem for herself in almost all the outlying Provinces of India. And its ~~Bhagnari~~ draught-breed is prized right up to the Punjab. The North-West Frontier Province Government is putting forth strenuous efforts to emulate the Punjab in animal husbandry. The Central Provinces with its Gaolao breed is trying to better the condition of the very large number of non-descript cattle which eke out a miserable existence in its vast forests and waste areas. The eastern Provinces of Bengal, Bihar, Orissa and Assam are full of ill-fed, emaciated and non-descript cattle, except a portion of Bihar where some better cattle exist. These eastern Provinces have much to learn about animal husbandry and have to work for creating a habit of raising fodder-crops for the proper maintenance of the vast and unwieldy number of poor cattle they possess.

It has been brought out by many experienced writers that the dry areas, where grazing is scarce, produce the best cattle both for milk and for draught. On the contrary, the low-lying rice areas with abundance of grazing in a particular season, have but poor animals. The survey of the Provinces will bring out the truth in this statement, and we shall be able to learn why it is so. In the following pages cow-keeping in Madras is described in some detail. It is a large Province, and here the breeding conditions vary considerably. By studying the Madras conditions of breeding and feeding and of the breeds, it would be possible to form an idea of what has been prevailing all over India, and it will not be necessary to take up all the Provinces in so much detail. For the other Provinces, it will be enough if the outstanding facts of the present times are brought out.

175. Nomadic breeders settle in Madras : Madras is favoured by nature for cattle-rearing. The climate is mild and health-giving. There are very extensive pasture grounds, forests and hills situated near villages and suitable for grazing. On the contrary, there are crowded areas in Madras where there are no pastures, and there is not enough rainfall to ensure certainty of obtaining crops. (11, 187, 369-'71)

176. Practice of rearing calf in areas of importation : In the remote past the favourable conditions of cattle-breeding attracted tribes of expert breeders owning excellent cattle. They gave up their nomadic habits and settled down in this land because of the very favourable conditions suitable for their occupation

of cattle-breeding. By their efforts and technics they improved the condition of the cattle in the areas inhabited by them. Their contact naturally served to grade up the cattle in those areas that were distant from them but were connected by trade.

There is a prevalent practice in this Province of rearing the calves by intermediate breeders who maintain them for 2 or 3 years, and then dispose of them in the various markets. Advantage was taken of the fact that character, the working capacity and longevity of the cattle, vary with the locality in which they are brought up and are made to work. If calves are taken to a locality differing in climate and reared there, such calves readily adapt themselves to the newer conditions, which the grown-up cattle cannot. For this reason, and for the varying conditions of climate and rainfall, it has become partly a practice in Madras for certain localities to rear the calves brought in from superior breeding tracts. Different areas again meet their particular requirements by choosing particular breeds of draught-animals.

177. Areas favourable for special breeds: In Coimbatore the Alambadi cattle of the north are said to have a working life of 6 to 7 years, whereas the local cattle of Coimbatore give 10 to 12 years of service. Further south, the full grown Alambadis are good only for two or three years' service and are, therefore, rarely seen. As against this, Alambadis are credited with 10 years service in the northern areas.

The acclimatisation of the calves in climates and soils is taken advantage of in several areas. For example, the Ceded Districts adjacent to Nellore and Guntur, having black cotton soil, require a heavy type of cattle such as that of the Ongole breed. If full-grown Ongole cattle from Guntur or Nellore are taken to the Ceded Districts, they soon wear out and have a short life, while young calves of the Ongole-breed, reared in the Ceded Districts, last 10 to 12 years or even longer. This fact accounts for the large movement of calves in this Presidency from one district to another. This provides occupation to a large number of traders, drovers and rearers. The calves are not usually bought by the *ryots* directly but by an intermediary who buys both for sale and partly also for rearing.

178. Coimbatore—a central cattle market : The dealers from Malabar flock to the market of Coimbatore and buy calves brought there from the north and south, Coimbatore being centrally situated to the breeding areas of the Presidency. The cattle taken to Malabar go to cultivate the Malabar soil after acclimatisation there, the local cattle of Malabar having become extremely poor in quality—a general feature of rice areas.

179. Cattle of dry and wet tracts : It is a remarkable fact that the cattle of the drier tracts of scarcity are better in every way than the local cattle of wet tracts having very often good seasonal pasture and succulent fodder. In the west coast there is plenty of succulent grass in the rainy

season, which dry up out of season. The excess fodder of the rains are not, under present circumstances, and probably cannot be, preserved for use during the dry months. The cattle of the west coast (Malabar) is noticeably poor and degenerate. True, even the local cattle of Malabar can be brought to fair form, and efforts are being made in that direction. But the generality of the cattle are poor. (184)

180. Tracts where cattle are regarded as a source of income : On the other hand, the breeds from Kangayam, north Salem and Ongole inhabit a dry locality liable to scarcity. Dryness, want of pasture, scarcity etc. induce the *ryot* to look to the cattle for their source of income, instead of wholly to the soil. They, therefore, take more care of their stock ; they learn to preserve fodder for seasons of scarcity ; and the dry climate helps them do so. They bring more care to the management of their cattle and ultimately contrive to get a living out of the stock, bred by them. The habit of taking care of the cattle becomes ingrained in their nature. In the wet area the seasonal plenty and adverseness of the climate to the preservation of fodder contribute to produce exactly the opposite effect. (255)

181. Influence of the nature of the soil : black soil : The nature of the soil influences both the breed and the type of the cattle. There are a variety of soil conditions that prevail. There are black cotton soil, the red or light soil, the well-irrigated soil, as also the wet soil etc.

The black cotton soil requires heavy, slow-moving cattle for deep ploughing. Here the cultivators get a good return for their land steadily year after year. They are better-off and are more provident. They take care to secure and rear strong cattle, powerful enough for the soil ; and they feed them well to get the best out of their cattle. (289)

182. **Light red soil :** In the light red soil the cultivator lives a precarious life, depending on uncertain showers for the success of his cultivation. The rain often fails. The sowing seasons are short. Quick moving cattle are, therefore, wanted so that sowing may be finished with the utmost expedition. The cattle naturally are poorer and smaller than those of the heavy soil. The cultivators, unable to provide enough food for their cattle, take the medium path of acting as breeder of calves for sale. During this period of breeding the young male calves, they make them work in their light soil and thus help them to grow up. They rear them carefully, and after these have given work for a season or two and attained to their full size, they are sold off, or even earlier, during the bad season.

183. **The tracts irrigated from wells :** In tracts irrigated from wells cattle of a heavy type are needed for drawing water from the wells. The amount of power required depends upon the depth of the well as well upon the size of the bucket customary for the locality. The cattle employed for heavy ploughing in the black soils, when they get weaker for their job, are utilised for working the *mhote* for drawing water. In such

places the cattle change hands according to their advancing age.

184. Light cattle for wet land: In wet land cultivation, as in the deltas or for rice fields, very light animals are needed, as, otherwise, the feet of the cattle sink deep into the soft soil and cannot be worked.

The worst cattle, the refuse of the cattle mart, therefore, go to these areas, where after a few seasons of hard work under unhealthy conditions in the poodled soil, necessary for the preparation of the fields, they die quickly and are replaced. (179)

185. Pastures and fodder: Forest grazing: With the variation of the character and the mineral constituents of the soil, the quality of vegetation grown on the soil varies. And this reflects on the cattle reared in the localities. The Malabar cattle, for example, have to graze and feed on vegetation deficient in minerals, because the soil is deficient. These cattle can never attain to any size or bigness of bones on account of the deficiency of lime both in the soil and in the fodders, unless they are stall-fed with proper concentrates and mineral feeds. In contrast to this, the cattle of the Kangayam and Ongole tracts, producing the two best known breeds of Madras, are reared on soils very rich in lime.

186. Influence of climate and rainfall: Apart from the composition of the soil, climate and rainfall also exercise great influence upon the nature of the cattle found in any tract. Then again, the nature of feed being the same, management accounts for a

great deal of difference in the cattle reared under the same conditions of climate and soil. For example, there are some forests in Madras capable of maintaining the cattle with feed. Different class of people take varying advantage of this, and as a result the same forest is utilised for the best and the worst cattle. Management also includes the power of employing capital and the capacity to look after the cattle.

187. Professional breeders for forest breeding : The regular breeders who make a profession of cattle-breeding and earn a good income, and those who have capital enough to maintain large breeding herds use the forests to the greatest good to themselves and to their breed of cattle. In the forests about Kollegal, north Bhavani, Dharampur and Hosur, the professional breeders take the utmost advantage possible from them. These breeders send their cattle to these forests where they are kept inside pens and are allowed to graze ; these discreet breeders take pains to see that only females and small calves are sent in parties with the selected breeding bull for the herd. No other males can be seen in the herds. The male stock is sold as yearlings so that there is no chance of any but the selected bull covering the cows when they come to heat. The male yearlings are sold to another class of traders who take them up for rearing and re-selling. The cows are maintained solely for their male calves which are sold off as yearlings. This brings money to the breeders and by discreet management the herd is kept pure and in

a fit condition. The yearlings are much prized. Throughout north Coimbatore, north Salem, west Chittoor and the adjoining tracts of the Mysore State, the rearing of bullocks from these forest-bred yearlings is a most important industry. Through this arrangement, the heavy draught-cattle are supplied to very large tracts. They go to Coimbatore and Chittoor, to north and south Arcot and other districts. But the pick of the animals are taken further south to Tanjore, Trichinopoly, Madura and Tinnevely to be used as coach bullocks for heavy draught.

These discreet breeders are very keen about the breeding bull, They know that the herd will deteriorate if they are not careful about what sort of uncastrated males come in contact with the cow. Grazing in forests is not satisfactory in the dry season. The cattle get emaciated, but manage to live on. And when the monsoon breaks out they put on flesh. (11, 144, 175, 369-'71)

188. **Breeding in the Bhadrachalam pasture :** Wretched animals are bred at the Bhadrachalam forests in the Godavari district where mixed and promiscuous grazing is the custom. The male stock of this place are not sold as yearlings ; and no body would care to buy them for rearing up. The male stock are reared with the herd and kept till full grown, and then sold at low prices.

189. **The village cattle near forests :** Besides these two types, another class of cattle graze in the forests. They come from villages which are situated

near the borders of the forests. The general practice in such cases is one of mixed grazing where all sorts of cattle, males and females, mix together, graze, and mate indiscriminately. As a result the cattle get deteriorated. It is found that the nearer the village is to a forest the more degraded the cattle are.

190. **Grazing by professional graziers :** There is yet another system of forest grazing in which a class of people collect the village cattle and take them away for grazing in the forests, and charge a small fee per head of cattle. They are returned in time for the cultivating season. The *ryot* has his cattle maintained during the off-season at a small cost. If it be Government forest then there are no restrictions over the cattle drover, who may do anything he likes with the cattle with him. Indiscriminate mating takes place by any sort of scrub and undeveloped bulls. But, that is not the only point. The collector of the cattle is not responsible for the life of the cattle taken out by him, and very often he makes short work of his troubles by slaughtering some animals for their hides, having to simply report to the owner that so many of his cattle have died. When the price of hides goes up in the market, the death rate increases.

There are, however, private grazing lands also in Madras, for example in the Nellore district. Here, under private owners, the pastures are better kept and the keepers of cattle pay more attention to the cattle although they charge more fees. The condition

of the cattle in such pastures remain better and the death rate is less.

191. Grazing in the village commons : As in the other Provinces, so in Madras, there are village commons where the cattle of the village are let out for grazing. Such village commons are so overstocked that they may be regarded more as exercise grounds than anything else.

192. The growing of fodder : In certain areas, particularly in Coimbatore, Salem, north Arcot and Trichinopoly, on account of the growing decrease of pasture grounds and also on account of the development of well-irrigation, the custom of growing fodder is on the increase. Wherever this practice has spread the cattle have improved by better feeding and consequent better management. Such cattle do fetch good prices and are a source of income to the *ryots*. In fact, the bringing under cultivation of pasture land instead of being a curse has become a bliss. The result of growing fodder is most noticeable in Coimbatore where the excellent custom of fencing off fields prevails. There is no chance of promiscuous, indiscriminate mating, and the feeding can be regulated by allowing fenced pastures to be grazed in rotation.

193. Stalks of cereals provide fodder : In the Ramnad, Madura and Tinnevely districts there was shortage of fodder on account of the introduction of Cambodia cotton. The cultivators soon found that they could obtain a better yield of cotton if they irrigated the fields and sowed cotton in rotation with a

cereal crop. This has ensured them fodder and more food for themselves and ready money from a crop like cotton. The stalks of cereals have less value than green fodder or fodder grown entirely for the purpose of feeding the cattle, without robbing them of their grains or seeds. Yet, even the stalks of cereals have food value left to them and they still provide something for the cattle in place of nothing. In the wet rice-areas, the paddy straw comes in beneficially for cattle maintenance, however deficient their nutritive value might be. But, even in this matter the tracts differ. South Kanara is a wet tract, and here the straw is well harvested, and cultivation is also in an advanced state. But in Malabar the cultivation is poor, and the sparsely-grown stalks of rice are collected in harvesting at half their height, the other half remaining in the fields. This neglect is reflected strikingly in the condition of the cattle.

194. Cultivated fodder : The cultivation of fodder crop for itself is practised in the two extreme ends of the Presidency—in the northern deltas and in the black cotton soil of the extreme south. In the northern area *Sunn hemp* is grown as fodder after the harvesting of paddy. In this area Cholum or *joar* is also grown as a first crop mainly for fodder before sowing the paddy. In the Guntur area of the north, which is the tract of the Ongole breed, *variga* (*Panicum Maleiacum*) is a special fodder. It is a short-duration crop and is a more certain one. In the black cotton area of the extreme south *cholum* is grown specially as fodder.

195. Breeding and rearing in Madras : Throughout the Madras Presidency two descriptions of cattle may be found to exist side by side. The one, bred with care in which the cows are either stall-fed or seasonally stall-and-pasture-fed and yet kept separate from males for the prevention of indiscriminate mating, and the other in which the cows are allowed to graze mixed, and there is no control over mating or the choice of a bull. Generally scrub bulls serve and deteriorate the progeny.

Where there is a selected bull for breeding, and particular care is taken of the cows, the cattle grow to greater size and strength, whereas only poor, depraved animals are multiplied by indiscriminate breeding by any bulls serving the neglected cows. (141)

196. Doddadana and Nadudana : The two famous breeding tracts of Mysore and the east coast also show these two forms of cattle side by side. One is called Doddadana or large cattle. These are bigger and well-shaped cattle having uniformity of size and colour. The other is called Nadudana or village cattle. These are of stunted growth and of various colours.

For breeding the Doddadana or the better cattle, the herd is served by superior choice-bulls which are kept in the village and home-fed. They are allowed with the herds when they go for grazing to the forests. A large majority of these bulls are dedicated to temples and held sacred. Occasionally service from immature calves of high class bulls is taken from

necessity. The male calves of the Doddadana are bought by a class of people when they are quite young, and these are reared in the villages. They are reared for sale after castration and after being broken to the plough. Up to the time that they are not castrated, they are allowed to serve. It is said that the progeny is not as superior as from the mature bulls, although, according to genetics, there seems to be no harm if an immature bull serves a cow, provided the number of services in a month is restricted to only a few.

The other class of inferior Nadudana cattle with which the land is teeming is developed out of mating by any kind of scrub bull. This leads to continual and growing deterioration of the stock. (141)

197. Better bulls for Doddadana breeding : The Amrit Mahal, the Hallikar, the Kangayam, the Alambadi and the Ongole breeds are Doddadana or the superior breeds. In some places the villagers club together and subscribe a bull, if suitable, dedicated or *Brahmani* bulls are not available or are not sufficient in number. Such superior bulls they maintain by common agreement by letting them graze unrestricted on the field-crops. They generally accompany the herd in their grazings and return home with them, and then forage at night or in the early morning before the herd is out. Such a bull, consequently, does not care for the scanty grazing to which the herds are led and where it also goes with them.

The cows of the better breeds are often kept at home and stall-fed, and the very best bulls are secured for serving them.

In the Ongole breeding tract the majority of the bulls are *Brahmani*. In the Vizagapatam tract some breeders maintain selected bulls, and the result is apparent in the highly-prized stock they possess. The bulls in this tract are of the Ongole breed.

In the Kangayam breeding tract there are no *Brahmani* bulls. There are rich breeders who possess large herds and maintain first-class bulls only. The breeding details of the Kangayam tract will be noticed when dealing with this breed later on. In this locality the poorer people come to the renowned breeders for having their cows served. In such cases, the condition is imposed generally that if the progeny is a male it will be sold to the owner of the bull. (141)

198. Better bulls secured in a variety of ways : In the famous breeding tracts of Coimbatore and north Salem, the District Boards are interesting themselves in supplying breeding bulls under what is known as the Premium System. The Co-operative Societies, the Agricultural Societies and the Village Panchayets are also developing the custom of purchasing bulls for the benefit of their members. The Madras Government Premium Bull Scheme is to grant a premium of Rs. 90/- per year for 3 years, provided that the bull is housed and maintained, and serves not less than 40 cows in the year.

In the southern districts there are no *Brahmani* or temple-dedicated bulls. The cultivators find it difficult to maintain bulls simply for breeding purpose.

Here, therefore, they depend upon the service of uncastrated, immature bulls of superior types which are later on castrated and sold, to be replaced by newer male calves.

In Madura there are some *Brahmani* bulls, while some very fine type of bulls are maintained for bull baiting—a sport which draws enthusiastic crowds. The Government Premium Bull Scheme is operating in this area, but the progress is slow.

The west coast, as has been already observed, is indifferent to cattle breeding. The cattle are dwarfed and the cows often fail to give milk enough to keep the calves in health. This is not peculiar to the west coast but may be said to be the special feature of many rice-growing wet tracts. In the west coast, however, a change is coming over the people, and some enthusiastic persons are purchasing high-class bulls for breeding and grading up the local stock. The Sindhi bull is a favourite here, and a number of them are being utilised. This practice is increasing.

In Tanjore quite a different motive operates on some land-owners for maintaining good breeding bulls. Cattle-owners are encouraged to send their cattle for grazing on the paddy lands. And these grazers get free service of high-class bull which the land-owner maintains. The invitation for grazing is inspired by the motive of having the paddy lands manured. The owner of a good bull attracts the largest number of cattle for manuring his fields. (141)

199. The trade in cattle : The whole of the cattle trade of the northern districts, such as Nellore and Guntur and the ceded districts, is in the hands of the Reddis of Nellore. Their trade take four main lines :

(i) The Bhadrachalam trade. This consists of importation of wet-land cattle for the delta area. These are the untrained, forest-bred, semi-wild cattle of Bhadrachalam on the Godavari river in the East Godavari district.

(ii) The trade in the districts of Cuddapah and Kurnool, these being a strip of territory between the Mysore State and the east coast districts. The cattle from the south are taken to Cuddapah and from the north are taken to Kurnool.

(iii) The import trade from the Mysore State into the districts of Anantapur and Bellary lying to the north of it.

(iv) The import trade from C. P. and Hyderabad of full-grown, forest-bred cattle to the north of the ceded districts and beyond Dharwar.

The peculiarity of the trade in the northern districts is that the Reddis, who exclusively handle this trade, sell the calves on three years credit to the *ryots*. The credit system has its advantages with obvious disadvantages. On account of this custom no important cattle marts or markets have developed in the area operated by them. And the choice of buyers is necessarily restricted. (251, 255, 304)

200. The Ongole cows for Madras city : The Nellore dealers also trade in the Ongole cows meant

for supply of milk to the city of Madras. The agents of the Reddi dealers go from house to house and choose the cows. These are brought to a shady grove of trees in the village and the Reddi dealer makes his final choice and settles the purchase. This they do from village to village in the district of Guntur. The cows are booked by rail to Tiruvalluvar near Madras and assembled there. The dealers from the town come here and buy whole-sale for supply to the *gowalas* of the city. These dealers sell mostly on credit to the professional *gowalas* or milkmen of the city. The poor milkmen can rarely rise above his indebtedness. Over and above his greed, the milkman's perpetual indebtedness to the dealers provides additional inducement to him for adulterating the milk. The dealers are exacting and live on the milkmen. When a cow dries the *gowala* looks to the dealer to give a new one in exchange, for a consideration of money. These dry cows of the excellent and covetable breed like the Ongole find their way to the slaughter house of Madras through the butchers. About 2,500 cows are annually importated into the city. This reckless and amazing waste of valuable cows has been going on from year to year. There is an arrangement now of returning the dry cows at a reduced railway fare to the grazing areas. But the number thus saved is insignificant, for there are other forces that operate and make the cows sterile and unworthy of further use for breeding. The calves are invariably lost. Most calves die of starvation and those that live

become useless on account of the starvation through which they pass during their most formative period. The national loss in this way from the cities in India, not only Madras but Calcutta, Bombay etc., is stupendous. There has been much discussion on this subject of late but no solution has been found. (67)

201. Cattle trade in the south : The cattle trade in the southern districts is distinct from the trade in the north. In the south, cattle fairs and cattle markets are outstanding features. In these markets a lot of retail dealing is carried on. In this trade the Chettis of North Arcot and of Salem are in the forefront. They purchase from the rearing tracts and sell in the southern fairs and markets. Some rich Vellala dealers make cash purchases and get the very pick of the cattle. Some Mussalman dealers trade largely in inferior cattle. The Telugu Chettis of Pollachi and some Maduvandis of Coimbatore are also important traders.

Coimbatore is a sort of central exchange market. Here, middle-aged black-soil cattle from the south are resold for working in the *mhotas* or wells after they had served for black-soil cultivation in their prime. They do well in working the *mhotas* when brought back to Coimbatore.

The Mysore State cattle, the north Salem cattle and the Kangayams are the principal attractions in the fairs of the south.

There are some regular routes along which the cattle drovers take the cattle successively from

one fair to another and from one direction to another.

202. The Ongole Tract Enquiry : An enquiry into the condition of the cows, their milk production and milk consumption was undertaken at the instance of the Government of India in seven breeding tracts of India famous for their breeds of milch cattle. The seven tracts selected were the Montgomery and the Hariana tract in the Punjab, the Kosi tract in the U. P., the Kankrej tract in the Bombay Presidency, the Ongole tract in the Madras Presidency and two similar tracts in Bihar and the Central Provinces. The survey was undertaken in September, 1936, and completed in January, 1937.

Facts about the Ongole tract will be discussed here. This report of the survey brings out in greater detail things already known about the Ongole tract and places them comparatively side by side with the facts and figures about the other tracts.

The Ongole tract being the habitat of the best milk-breed of southern India was selected for the survey. This tract comprises an area lying in the districts of Kistna, Guntur and Nellore. It extends from the sea coast to a distance of about 100 miles inland and is bounded on the north by the rivers Kistna and Manneru.

The tract is of heavy black soil, containing plenty of lime. The average rainfall is 30 inches. The conditions here are regarded to be favourable for cattle-breeding. A survey of 50 villages in this area was taken up and in each village 20 holdings were

selected at random to obtain the data. Ongole is the only tract of all the seven surveyed tracts in which all the holdings own cattle. It will be misleading if we take this to be the general picture of the milk production of the Presidency.

But this particular tract where the famous Ongole breed is reared is distinct and shows features peculiar to itself, and in some milking matter is second to none in the whole of India. This will be brought out in course of this review. (67, 258, 266, 287, 302, 336, 344)

203. Holdings and cattle in the Ongole tract : The average holding in this tract is of 23 acres, a thing which the cultivators in the densely-populated Provinces of Bengal and Bihar cannot dream of. In each holding there are 6·9 persons of which 3·7 are males and 3·2 are females.

For cultivating these 23 acres belonging to a holding of 6·9 persons in the family, the Ongole population keeps 2·64 work bullocks. This means that a pair of bullocks here cultivate 18 acres of land, again a high figure next only to the Kankrej area of Bombay where a pair of bullocks cultivate 25 acres.

Of the milch cattle, this tract maintains 2·2 heads of cow and 1·9 heads of she-buffalo or in total 4·1 heads of milk-giving cattle per holding of 6·9 persons. A very high figure again, next only to the Kankrej tract. *Per capita* production of milk is highest in this area being 35·33 ounces ; the consumption of milk and milk equivalents being 8·73 ounces. The surplus is sold as *ghee*.

204. Statement to show the position of cattle in relation to cultivation and milk production in seven breeding tracts:

TABLE-8.

Tract.	Cultivated acres.			No. of			No. per holding.			Percentage in milk.		Per capita.	
	No. of acres			per holding			No. per holding.			in milk.		Consumption in milk	
	Male	Female	Total	per holding	per bullock	per Cow	Cow	Buffalo	Total	Cow	Buffalo	of milk production	in milk
Montgomery	3.8	3.1	6.9	22.6	6.1	1.0	2.1	3.1	40	50	26.11	15.53	
Hariana	3.7	3.1	6.8	12.8	7.0	0.9	1.1	2.0	31	83	31.03	12.39	
Kosi (U. P.)	3.3	2.8	6.1	11.7	7.0	0.9	1.4	2.3	33	64	21.32	9.71	
Bihar (Deltaic tract)	4.7	4.3	9.0	6.9	3.6	1.4	0.5	1.9	55	56	7.85	5.51	
Central													
Provinces	3.2	3.3	6.5	21.9	6.6	2.1	1.1	3.2	22	57	13.38	6.73	
Kankrej													
(Bombay)	3.1	3.0	6.1	21.4	12.6	2.6	1.6	4.2	22	57	29.88	12.07	
Ongole													
(Madras)	3.7	3.2	6.9	23.2	9.0	2.2	1.9	4.1	55	55	35.33	8.73	

205. Milk production and consumption in Ongole tract: From the survey certain conclusions of great importance may be brought out. The poverty of the people come out in the lime-light. In the Ongole tract there is not a single holding without milking animals, and the production per head of population is as high as 35·33 ounces. This brings the total production per family to about 15 lbs. a day in a family of 6·9. Yet, in a locality producing so much milk in every holding, there are holdings in which all the milk is sold away, and nothing is kept even for the children. The number of such non-consuming holdings amongst all the milk-producing holdings is 10 for every 100 holdings ! (67)

206. Present position of cattle-breeding in Madras: In closing this general description of Madras cattle, it is necessary to mention that in Madras, as elsewhere, the cattle are being more increasingly neglected with the increasing poverty of the people. Down-trodden and fallen as the *ryot* is, he is forced to take up a position in which he comes to care for the work animals first and the male calves next. With an under-fed and undeveloped dam, her off-springs, the bull and the bullock, cannot take up that form which they would have taken up. In the next step a poor bull gives rise to poorer progeny.

207. Cereals and money crop: The *ryot* expects his breeding cows to pick up what she can in the pastures or along the road sides of villages or in the adjacent vacant lands or in the commons. She returns

as hungry as when she started for her roamings in the morning. The *ryot* may throw some straw to her for the night; he cannot afford at present to feed his stock. Everywhere the cows are neglected and it is a general feature. The *ryot* cannot grow fodder crops for his cattle. Even cereals, the stalks of which go to feed the cattle, are being less and less grown, the pressure being for the cultivation of money-crops. And money is more and more vanishing although the *ryot* is in pursuit of it.

208. Possibilities of the Madras breeds: Innumerable, miserable, living skeletons of cattle can be seen, under-fed and uncared for. Many of these are worthless and too weedy even for the lightest ploughing work. And this is the land of the still existing famous Ongole, Amrit Mahal, Hallikar and Kangayam breeds. There was no bar to every cow in Madras being an Ongole cow. The Ongoles might, under care, be sufficiently prolific to cover the whole of Madras, and even today about 2,500 of them die annually a premature death in the city of Madras. Imagine, what would have happened if this annual slaughter could be stopped. They would be doubling themselves almost every third year and would be capable of filling the whole Presidency with their progeny. Similarly, about the Amrit Mahals and the Hallikars. Why Madras alone—the high class cattle of Madras—could, under proper management, fill India with excellent progeny inferior to none in the world! This is attainable. In a free country such things are

achieved. In Madras the *ryot* knows cattle-breeding. He knows the value of good bulls. He knows almost to perfection how to propagate a particular type of a special size and colour by in-breeding and line-breeding. But with all these he remains what he is! If his handicaps were removed he could take his proper place in the economic life of a better India.

209. Impetus to improvement : Madras is making headway with the general impetus given in India to cattle improvement from 1936. The Viceroy's scheme for gift bull did not make much impression in Madras, because Madras was already in the field for some time past with its Premium Bull System by which a part of the maintenance expense was borne by the Government. This is so much to the credit of the Government of Madras.

A standing Fodder and Grazing Committee was formed in Madras to improve fodder supply. In Mysore the Amrit Mahal reserve-pastures have been thrown open to private owners of cattle. The Madras Government has a scheme of allotting a percentage of irrigated land, free of water cess, if fodder is grown. It also desires to reserve areas for fodder in all future irrigation schemes.

Both the Government and the District Boards are striving more and more for supplying selected breeding bulls to the *ryots*.

210. Madras Government breed-improvement scheme : In 1942 the Government of Madras allocated a sum of Rs. 50,000/- for the improvement

of live-stock from the Government of India fund for Rural Development.

The Scheme was as under :

(1) To purchase and distribute the following breeding bulls :—

Sindhi bulls	...	25
Kangayams	...	20
Hallikars	...	20
Ongoles	...	20
Bikaner rams	...	100

(2) To purchase and distribute young male calves of 1½ years of age to be reared and then used as stud bulls on reaching maturity. For rearing Rs. 50/- per year for 2 years will be given.

Kangayams	...	20
Ongoles	...	15
Murrah buffaloes	...	50

The condition was that the adult bulls were to be properly housed and maintained, and should serve at least 120 cows in 2 years ; after which the bull will become the property of the custodian. The young bulls after 2 years were to come under the category of adult bulls and fall under the same scheme. The charges for maintaining the adult bulls was to be met from the Provincial funds as in the Premium Bull Scheme.

This is some attempt at stopping deterioration and not really improvement. Capt. Littlewood mentioned that the Madras cattle are not what they

were 20 years ago. Rapid has been the deterioration, and it still continues. Along with this, it has to be considered that the high-class cattle of Madras had been evolved and maintained during hundreds of years in the past.

The supervisor's note on the Ongole Tract Enquiry confirms the observation of Captain Littlewood regarding the continual shrinkage of fodder and pasture land with the increase of population. The common causes of deterioration are also found to be the well-known factors.

211. Ryots have lost their interest in cows : The cattle industry constitutes a secondary occupation to the agriculturalists. But the "cattle industry has now received a severe set-back owing to various causes. Most animals, especially cows, are ill fed, and naturally in very poor condition and a deterioration in the breed is in evidence. The ryots have lost their interest in cows. They have reduced their area under cereals to such an extent that they grow only sufficient grain for their requirements and straw for the work cattle.

The breeding, no less than feeding, is the main cause of deterioration of stock....."

—(*Seven Breeding Tracts Enquiry*.—P. 97)

When, however, the report says that the *ryot* has lost interest in the cow, it means that he has lost interest in life itself. But this is not true of every breeding tract. Where the *ryot* gets some return for his labour, he clinches on to the work. The position in the Kangayam tract may serve as an example. (589)

212. The Kangayam breeders' interest in cattle :
“... .. Kangayam tract in Coimbatore district produces a fine breed of draught-animals. The soil here is light and the rainfall precarious. There is always an uncertainty about raising crops while cattle are a much more certain source of income from the land. The ryot has to depend on his wells for his cereal crops but he is able to maintain fairly good pastures with the scanty rains he gets. The area contains no common grazing grounds. Fenced private pastures are a regular feature of the tract. There is no promiscuous breeding as the animals are grazed separate, according to the age and class of the stock. Male stock 2 to 3 years old, castrated and broken to work, are marketed in cattle markets and fairs.” (*Ibid.*—P. 98) (43)

213. Fencing of fields and well-irrigation improve the cattle : The fencing of fields and well-irrigation have been a bliss for the Kangayam tract. Instead of blaming the *ryot* for his lack of interest in the cow, it is for the Government to find out the cause and remove the difficulties. For, the lack of interest in the *ryot* is only apparent. He is keenly interested, but his helplessness makes him apathetic as it will do any one else. His difficult position is due to no fault of his but to the political position of the country over which he has no direct hand.

214. The Ongole tract and breed : In the Ongole tract, cattle-breeding has been a profession for a long time. People found that by cattle-breeding they

could avoid the harassment of the rent officials, and at the same time earn a living out of breeding of the very superior classes of cattle they possessed. The best Ongole cattle are found in the interior and in the northern parts. In the Ongole *taluka* itself there are villages deserving special mention such as as Karumanchi, Cidamanur, Pondur, Jayavarum, Tangloor and Karavadi, and in the Kandukur *taluka* of the Nellore district in the hamlets along the river Musi. The southern part of Nellore is a wet-crop area and consequently the cattle are much inferior there.

The system of feeding is dependent upon the pasturage available. Owing to the shortage of pasturage, the dry cows are now sent to distant forests for grazing. In the alluvium of the Ongole *taluka* there are no large breeders, but in the shallower black-soil area about Kandukur there are larger breeders owning herds of upto 50 heads of cattle. The small breeders pay more attention to feeding than the larger breeders. At one time, one-sixth of the *patta* lands were kept fallow for pasture in the Ongole *taluka* varying with the fertility of the soil.

Pasture feeding is supplemented by stall-feeding with grass. The stalks of *joar* and the *bhusa* of pulses are also given when the cattle remain at home. In the Ongole *taluka* the grazing land is principally the river-banks and adjoining fallow lands liable to be flooded. (67)

215. **Ongole ryots are expert breeders :** The *ryots* of this tract with ages of experience behind

them are competent breeders and understand the value of the feeding of the stock and the value of good bulls. They may be called experts in breeding. Circumstances have changed and in spite of their expert knowledge their herds are dwindling in size. At one time every village had one or two excellent bulls. (67)

216. Ongole tract : good bulls are scarce : Every important *ryot* possessed a good bull of his own. Now all that is changed. The villagers depend upon the *Brahmani* bulls of any sort, and these lose condition in the summer months for want of enough food. Over and above this, the young bulls meant for being used as bullocks, are not castrated till they are three or four years old. And they also serve. By excessive serving they lose condition. It is difficult to meet with a really good bull now-a-days in this once-famous area.

217. Ongole tract : double wrong to the cows : The majority of the cows are ill-fed and only the well-to-do *ryots* can afford to maintain them properly. The 'Malas' who make a profession of rearing for the Madras market, however, take good care of these calves and heifers. But ordinarily the cow gets the remnants of straw from the mangers of work bullocks. The *ryots'* wives now look to the buffalo for an additional income. The oxen belong to the family but the she-buffaloes belong to them and they take good care of them and make a small income by selling *ghee*. This is bad economy. To allow the cow to starve, to give her the remnants of food after

feeding the bullocks and yet to expect her or her progeny to give full milk is wrong, and then to discard her as a milk animal and adopt the buffalo for milk is doubly wrong.

218. The Ongole cow : table of yield : The neglect meted out to the Ongole cow is reflected in her calving at long periods and in her going barren after 4 or 5 calvings. The daily milk production, the dry period, the calving interval and the total production per lactation of the Ongole cows, according to the Village Enquiry Report of 1937, and Mr. Kartha's report are as under :

TABLE—9

Milk yield of the Ongole cow.

Average milk yield per day	...	4.64 lbs.
Average lactation length	...	9.54 months.
Average dry period.	...	9.47 months.
Average calving interval.	...	19.03 months.
Average milk yield per lactation.		1,236.4 lbs.

When the cow comes to heat at home, the owner tries to secure the best available bull, but when the cows are in the pastures promiscuous mating takes place. Those who make bull-calf rearing a profession allow all the milk of the dam for the calf. Close to the towns where cow-milk is in demand, the cows with female calves are milked. Those that are kept in the towns themselves for milk, have to yield practically all their milk to the owner, and both the male and the female calves are starved. In the villages the bull-calf receives much better attention and feeding than the

heifer-calf. The bull-calf is given a little concentrate while the female calf is allowed what she can pick up of fodder from the refuse left by the work-cattle. The *ryot* expects to make a good work-animal of the male calf which will realise a fairly good price, hence this difference of care.

219. Ongole : Mala women care for dairy heifers :

The order of care and feeding is as follows : The best attention is given to the working bullocks, next the bull calves, next cows with bull calves and last of all the cow and the heifer—a situation from which no improvement in stock can be expected. On the contrary, it is one in which deterioration is bound to result at a rapid pace, as is observable now. The Dairy heifers are bred, however, with the same care as generally falls to the lot of the male calves. The *Malas* take to rearing the dairy heifers. They are a weaver class in addition to their being field labourers. The women of the *Malas* collect grass in their spare time to feed the calves or get grass in return for their labour as part of their wages from the cultivators. When they assist the *ryots* in harvesting, the *Mala* women collect a sufficient quantity of fodder and store these. This dry fodder is supplemented with green grass collected daily for feeding the calves which come to heat in about 30 months. The *Mala* sells the heifers when they are in calf and buys another calf with the money earned. If any dry cow will come back from Madras for maintenance during the dry period a *Mala* will charge a maintenance allowance of Rs. 6/8/- per month (1936) and get a reward of a.

piece of a cloth or a turban at the time of the return of the calf and the cow. (236, 257, 278, 303, 372-'76)

220. Ongole fodders : sunn hemp & paddy straw : The chief fodders grown are *jonna* (andropogon Sorghum), *sunn hemp* and some pulses. Generally *jonna* and pulses are grown for grain and the straw is fed to the cattle.

Sunn hemp is grown in the delta tracts. *Sunn hemp* and paddy straw constitute fodder, and large surpluses of these go to the dry areas. In years of scarcity of rainfall thousands of cart loads of paddy straw are transported from the delta to the dry tracts.

Forest grazing is taken advantage of and most of the cattle are sent away to graze there early in June.

221. Madras cattle survey of 1937 : In 1937-'38 a survey of the cattle of this tract was made. In the 844 villages visited there were 93,000 cows of the Ongole breed, and 789 breeding bulls of which 719 were old and useless. The number of bulls was very inadequate and the district was short of more than 300 bulls at the time. In 316 villages there were no breeding bulls at all.

In the area 42 thousand calves were born annually of which nearly half the calves were female. Of the heifers 2,500 went to Madras, and of the bull-calves half were sold away for other areas,

222. Ongole cattle in other lands : In the August issue (1941) of the "Indian Farming" there are several

photographs of Ongole cattle in South America. The editorial comments on the Indian breeds in foreign countries throw interesting light on the problem of improvement of Indian breeds and the export of cattle.

“.....the photographs of the Ongole cattle received recently from the Department of Agriculture, Brazil, show how well Indian cattle thrive in America. These animals are the progeny of Ongole cattle exported years ago from Madras, and it will be seen that they compare very well with the best Ongole animals now available in India. Encouraging reports have also been received regarding other breeds like the Gir, the Kankrej and the Sahiwal.”

“.....the development of the export market is bound to have a far-reaching effect on the production and rearing of pedigree stock in India, but if production does not keep pace with demand, or if sales are not controlled, there may be severe depletion in the numbers of high-class breeding stock and eventual extinction of a breed. This is illustrated in the case of the Ongole. Large batches of this breed, including females, were exported at one time and production was crippled owing to the land on which these cattle had been reared being immediately taken up for other purposes. This led to the virtual extinction of the breed, and although the export of Ongole cattle was prohibited, the damage was done and prohibition has not helped substantially to revive the breed.....”

As a solution, the Editorial Board suggested control. The remark, however, of the Editor seems to be superficial. Export may have at one time done injury ; but even now the performance of the average Ongole cow is not much below that of the famous Sahiwal.

223. Ongole and Sahiwal : The Report of 1937 brought out that the average daily milk-yield of the Ongole was 4.64 lbs. as against 4.72 of the Sahiwal. The Ongole came next to the Sahiwal. The Ongole was a better cow in the past than she is today. But this is true of every breed today. That the general degradation has not come on account of export but for many other causes which are still operating cannot be disputed from the materials placed herein. (258-'63)

224. The real cause of deterioration : Sir Arthur Olver seems to have grasped the Indian problem of Animal Husbandry in its correct perspective. Referring to the *ryots*' share of blame in the deterioration of the cattle, he opined that "the present condition is due to want of effective Government organisations for Animal Husbandry."

"Much of the live-stock-work seems in fact to have been started at the wrong end, since it is no use expecting the *ryot* any more than the cultivator of other countries to spend money on improving his stock unless he can foresee a satisfactory return therefrom."

225. Comparative statement of the cattle of the Seven Tracts :

TABLE - 10

	India's seven breeding tracts.	Mont- gomery.	Haryana, Kosi.	Bihar.	C. P.	Kankrej.	Ongole.
Average milk- yield per day in lbs.	3.74	4.72	4.46	3.89	2.74	1.67	3.90
Average lactation length in months.	8.81	10.43	7.62	8.25	8.14	8.94	7.90
Average dry period in months.	9.21	7.24	7.62	8.31	8.48	11.80	10.21
Average calving interval in months.	18.20	17.68	15.24	16.61	17.03	20.74	18.24
Estimated average lactation yield in lbs.	943.0	1343.8	986.0	865.0	651.3	411.3	919.8
							1236.4
							—(67)

226. The Kangayam tract and breed : Kangayam is a *taluka* in the Coimbatore district. The breed takes its name from the *taluka*. A cursory observer passing through the Kangayam *taluka* or attending the local fairs will rarely find so fine animals as are met with and sold at fairs in the southern districts. The reason is plain. The best cattle are exported and the medium-grade of local cattle serves to meet the needs of the *ryots*. Another factor is the costliness of the Kangayam and the cheapness of the Alambadi cattle of the north. Local people will dispose of their superior Kangayam bullocks and buy the Alambadi for the cultivation of their own land.

The breeding area consists of the Dharampura *taluka* and the adjacent ones of Pallandam, Erode, Karur, Palni and Dindigal. Breeding, however, centres round the Dharampura *taluka*. The breeding tract is red loam, full of cankar gravel. This sort of soil is uncertain and will very often fail in crops. But fortunately whatever be the rain-fall, the pastures do maintain the cattle. It is, therefore, that the *ryots* have chosen two certain paths. In the dry soil they grow a well-irrigated crop which is not dependent on nature, and the red loamy shallow soil they use for pastures and breed cattle which pays them more than if the soil was used for the production of crops. (43, 108, 252)

227. Pastures and fodder : In the Kangayam tract, rain-fall, though distributed throughout the year, is always precarious; there is always uncertainty about it, and the cattle are a much more certain source of

income. The *ryots* have avoided chance and risk in another matter too. They fence their fields and therefore, can regulate the feeding on their pastures and when necessary grow crops after breaking up the pastures. Fencing is an essential feature of the Kangayam tract, and without this the pastures on which they feed their fine cattle, would be spoiled. They have been favoured by nature in the matter of grass also. (43)

228. Kolukkatai grass-growing in the Kangayam Tract : Kolukkatai or the Anjan grass (*Pennisetum cenchroides*), the best of grasses, it may be said, grows here plentifully. These pastures are the main-stay of the cattle. There is really no economic loss in growing grass from a wider point of view of meeting the requirement of cereal crops. The pastures are occasionally broken up for crop cultivation. The manures having been allowed to remain in the fields, the crops grow in plenty, much more heavily than they would otherwise do. The Kolukkatai is a grass with bulbous roots and retains moisture and, therefore, can maintain its vitality even through the severest drought. This grass seeds freely and the seeds are easily shed. So that after a shower of rains new shoots crop up in a rush and grow to a foot in a few weeks.

The un-irrigated crop of Dharampura is *cumbu*. Cholum is grown on well-irrigated land. But the poorer *ryots* grow *cholum* for a double purpose, grains for himself and stalks for the cow. They can get rice straw also, but Cholum straw is a superior fodder.

The large stacks of rice straw and *cholum* stalks are a feature of the landscape of this area. (43)

229. Stock-rearing in the Kangayam Tract : The stock is reared for providing bullocks for sale. The male calves are, therefore, most prized. For the first six weeks the calf gets all the milk from its dam. When it has learnt to eat it is turned to pasture, and the amount of milk is gradually diminished. Small breeders take more individual care of the calves. To the promising male calves they allow all the milk that they can give, and if the dam's milk-yield is not considered sufficient, extra milk is obtained and the calf is hand-fed.

The cows and calves are maintained on pastures, and when these are not available, they are given fodder supplemented by some concentrates in the form of pulse husks or *bhusa*, the bran of cereals, the ground pod of white *babul*, or ground cotton seed mixed with rice water.

The young bulls are castrated when they get the second pair of teeth and then broken to the yoke before sale. (43)

230. The best Kangayam breeding : There are two varieties of Kangayams, the larger and the smaller. The smaller variety is the more numerous. The celebrated Kangayam cattle are not the common cattle of Kangayam. That famous breed of cattle is the property and product of large breeders, prominent among whom is the Pattagar of Palayakottai and other members of his family. There are also other big breeders like the Kadiyar Munsif Monigar.

Some middle-stationed *ryots* breed 10 to 12 heads of cattle. But the larger breeders keep herds of 500 to 1,000 cattle. The breeding practice of the Pattagar of Palayakottai is scientific and deserves special mention. Captain Littlewood observed about him that it was doubtful if there was another land-owner in India who paid so much attention to or carried out systematic cattle-breeding on such good lines as the Pattagar.

The Pattagar owns an estate of about 14,000 acres. There is a proper selection of sires and dams. The poor dams are not used for breeding. There is a way for the disposal of the inefficient dams. The poorer *ryots*, when they find that a cow will not come to heat, uses her for the plough or for drawing up water or for any other work except carting. The larger breeders are, therefore, not saddled with useless cows nor are the petty breeders. But, it is a fact that the rejections amongst the cows go to the poor, petty *ryot*. He lets the cow to be covered when she comes to heat, thus producing inferior cattle. If the petty *ryots*, using the inferior females for agriculture, had not allowed her to calve, it would have been a very commendable practice leading to the elimination of the inferior stock.

The Pattagar provided considerable areas of pasture land to his herd. He separated the herds into different ages and sexes and kept them in the fenced pastures, where, therefore, there could be no mixing.

The prevailing colour of his cattle was white with grey marking about the hump and the quarters.

There were many fawns, fawn whites and even light reds. This showed intermixture of blood presumably with the Ongole, of which breed the Pattagar keeps a few. The coloured cattle, although of nice make-up, are not so much prized and naturally so.

The bulls are of dark-grey colour verging on to black on the head, the hump and the quarters. The segregated herds of the Pattagar, the heifers of two to three years age, and the larger castrated bullocks of three years or over, ready for sale, are a sight to see. The Pattagar sells both cows and bulls for breeding purposes in addition to the draught cattle. A pair of average Kangayam bullocks will cost Rs. 300/- to Rs. 400/- while a good pair from breeders like the Pattagar will cost Rs. 400/- to Rs. 600/- (1936). A good cow will fetch Rs. 100/- while one from the Pattagar will cost Rs. 150/- to Rs. 250/-.

The Imperial Council of Agricultural Research sanctioned a scheme in 1941-'42 for experimenting for 6 years on the Kangayam cows of the herd of the Pattagar of Palayakottai, with a view to improving the milk capacity of the Kangayam cows without impairing their draught quality. (43)

231. The Amrit Mahal draught breed of Mysore : Amrit is nectar representing milk. Amrit Mahal is the Milk Department of the Government of Mysore. But it is not milk that gave importance to the Mahal and the breed. It is the draught-quality of this particular breed of cattle which required the Mahal to be set up and maintained. The Amrit Mahal has an interesting history connected with the

immediate past when British power was slowly but surely taking up bits of territory in India. Mysore was one of the victims, and in the vicissitudes of fortune that accompanied the adventures of Hyder Ali, Tippu Sultan and the British, the Amrit Mahal draught-cattle played their part as draught-animals for the power that possessed them for the time.

It was Chikka Devraj Wodayar (1672—1704) who made a royal department for maintaining this breed of cattle and called it “Benne Chavadi” or the milk establishment. He branded the individuals of the herd with his own seal. After him Hyder Ali occupied the country. He made a great capital of this breed of cattle, and as the conquest went on he appropriated the best cattle from the owners and included them in the royal stud. He is said to have maintained 60,000 bullocks in different parts of the Province. When his son Tippu Sultan succeeded him, he organised the stud to the minutest detail with masterly effect. He changed the name of the department to Amrit Mahal. He created regulations for the management of the department which was followed by the British officers after they got Mysore into their possession. (41, 318)

232. Amrit Mahal in Hyder's hands : The British came to understand the excellence of the Amrit Mahal bullocks which had enabled Hyder Ali to march 100 miles in two days and a half to the relief of Chellumbrum. These enabled Hyder at every withdrawal to remove his guns before the enemy.

Tippu Sultan, soon after Hyder, brought the Amrit Mahals to excellent use in crossing the southern Peninsula in a month for the recovery of Bednare, and covered also a distance of 63 miles in two days. After him the Duke of Wellington worked wonders with the help of these Amrit Mahals. (41)

233. Amrit Mahal in British possession: After the fall of Tippu Sultan and the handing over of Mysore to the Maharaja, these cattle remained British property to be managed by the Maharaja. These deteriorated under this management which was taken over by the Madras Commissariat in 1813. In 1864 the herd was ordered to be sold on grounds of economy. But in six years the Government found out its mistake and wanted to re-assemble the herd by purchase of such stock as were then available. But very few were obtained, the Pasha of Egypt having secured most of the best blood. But the Maharaja was a large purchaser also and the Government could start with a new herd of 4,000 cows and 100 bulls in 1870. In 1883 the whole herd was again purchased by the Maharaja who tried to improve the herd as much as possible. Later on, with the advent of motor transport the Mysore Government reduced the stock from 12,000 to 6,000, and the control of the herd was transferred from the Military Department to the Agricultural Department of Mysore. (41)

234. Amrit Mahal during changes of management: During the period that the herd was sold out by the Government it suffered great deterioration,

and the subsequent breed with all the efforts made for improvement cannot be said to be as pure as the breed that existed in 1800. A large number of inferior cows, and cows of the Mahadeswarbetta breed, is said to have been passed off as Amrit Mahal at the time of the re-establishment of the herd.

The Amrit Mahals are kept on pastures which are divided and classified for use in different seasons of the year according to their location. They are sent out to pastures and return to their home *maidan* or field at the beginning of September each year when the supply of grass is plentiful. (41)

235. Nature of the Amrit Mahal animals : In disposition the cattle are wild, unruly, and impatient of the presence of strangers. They have to be broken in by patient, kind treatment. They are to be gradually broken for the yoke ; and harsh treatment only makes them stubborn. The calves are castrated in the cold season when they are only 18 months old. The bullocks are sold at 3 or 4 years of age and come to full vigour at 5 years—which continues to 12 years. They work till they are 14 or 15 and then rapidly decline and die at about 18 years of age.

The heifers comes to calve at 4, 5 or 6 years, according to the care with which they are reared. The bull is used when it reaches 4 years, and is kept for service till 9 or 10 years of age. After that age the bulls are castrated and discarded from the herd. (41)

236. The female of Amrit Mahals: The cows come to heat and calve only at seasons suitable for calf-rearing. The most favourable time for breeding is January—February, and again August to December. The calves remain with their mothers during the day and are kept in sheltered folds at night. Living with the herd in the open the bull calves get wild with age. In order to improve the breed which had suffered deterioration, as already described, the British Government opened a farm at Ajjampur in 1939 where 500 cows were maintained on scientific lines. Suitable breeding bulls in a domesticated condition are supplied to villagers from here.

At the Ajjampur farm the Amrit Mahal cows are being bred for milking also and considerable success has been obtained in developing the milking quality of the cows without affecting the draught quality of their male off-spring. (41, 219, 257, 278, 303, 372-'76)

237. Hallikar breed: The Hallikar is the most important and valuable member of the Amrit Mahal. They are found in the Government Amrit Mahal herds, and also in the Tumkur, Hassan and Mysore districts. The Hallikars are generally home-fed, there being no extensive pastures where they might be kept. They are frequently kept by small *ryots* who own only a small number of cows. The mating receives special attention and the calves are reared with care.

“Gajamaru” is the most valuable variety of the Hallikar breed, and fetches high prices. The cattle are sent out to distant jungles from the Nagmangala *taluka*, their habitat. (42)

238. Alambadi breed : In the Coimbatore district two fairs are held which are the chief markets of these bullocks and derive their name from the place where they are penned for sale. The chief habitat is the Kankanahalli *taluka* of the Bangalore district, and the northern portions of the Coimbatore and Salem districts along the Cauvery on the borders of Mysore. There is a wide expanse of forest land here teeming with cattle. The banks of the Cauvery afford abundant pasture. In villages bordering on these jungles large herds are kept. The habitat of the breed is favourable to the development of their bones. The breeding grounds proper are the forests of the Kollegal and North Bhavani *talukas* of the Coimbatore district and the Hosur and Dharampura *talukas* of the Salem district. (47)

239. Barghur breed : The cattle of the Barghur hills, although they are also called Alambadi, are regarded as a separate breed. The difference is only that in the Barghur hills, the cattle are not bred with the same care.

In the regular breeding tract the Alambadi male calves are sold when young, under one year old, to the recognized rearing tracts of north Salem, west Chittoor and the adjoining Mysore territory. From the Dharampura fairs a large number of calves are taken away to the west coast for rearing.

All the male calves being practically sold, there are few bullocks here and the cultivation is all done by the cows. The breeding herds live in the forests for the greater part of the year and are brought to the villages about harvesting time when the harvested fields afford pasture for them and the cattle in return supply the necessary manure for the succeeding crop. When their grazing is finished the cattle are sent back to the forests. (46)

240. The Tanjore breed : In Tanjore there is a breed to which the breeders give a peculiar appearance by preventing the growth of horns in the males and by the cutting of 2 or 3 inches from the ear. The de-horning makes the males more docile. The cows are not de-horned. They are poor milkers.

241. Breeding in the Punjab : Great developments have been made during recent years in animal husbandry work in the Punjab. The Royal Commission Report on Agriculture (1927), in dealing with the animal husbandry work in the Punjab, discussed elaborately the Hissar cattle. There was only a passing mention of the Montgomery and Dhanni breeds.

It was natural that it should be so. The Royal Commission was obsessed with the idea that the cow is to be reared for giving draught-cattle and the buffalo for milk, and that the Hissar was the most important cattle for draught on the road and for field work. Here again the Commission deprecated the attitude of the breeders in trying to breed more milk into the draught-type and warned those

concerned about the dangers of a deterioration of the draught-quality. The story of the Hissar Cattle Farm is intimately connected with cattle improvement work in the Punjab, and it is worth while to know about it as presented in the report of the Royal Commission on Agriculture.

242. The Hissar Cattle Farm: The Hissar Cattle-Breeding Farm of the Government of the Punjab had an area of 42,000 acres and was the largest stock-breeding farm in India. It was the oldest farm started in 1809 for horse-breeding to which cattle-breeding was added in 1815. In course of time horse-breeding fell practically into insignificance, and from 1850 Hissar has been a farm for the raising of artillery and ordnance bullocks. One very remarkable and fortunate thing about this farm is that for 20 years the farm was controlled by two men and they were succeeded by Mr. Quirke who directed its policy for 18 years thereafter, up to the time of his death in 1938. So the Hissar farm had a continuity of policy over a very long range of years. The farm under Government control allowed a lot of crossing which proved undesirable. Later on, the undesirable tracts were gradually eliminated. Hissar represents a special strain of the Haryana breed. During the last decade the Hissar Farm maintained about 6,000 cattle in which there were cows. The farm auctioned in those days 300 to 400 young bulls every year. The work of the farm has considerably increased, and at present an annual output of 1,000 breeding bulls are expected. It is from this farm that Gurgaon has

been taking stud bulls to grade up the draught-cattle of the district, so much known for village uplift work attempted there by its Deputy Commissioner, Mr. Brayne.

At the time of the Royal Commission, the Haryana breed of cattle in the Hissar farm was regarded essentially as of a draught-type, although even then good milkers giving 3,000 to 4,000 lbs. were not uncommon. About that time the good milkers were separated as they required separate treatment i.e. better feeding during the lactation period.

At the Hissar ranch, the cattle are simply allowed to graze in the extensive pastures. In the years of fodder scarcity a little hay is given to them. For collecting the day's requirement of food in season, a breeding cow has to walk 10 to 15 miles. When dry, these cows weighing 1,100 lbs. require 40 lbs. of equivalent of green grass daily, and it was pointed out to the Royal Commission that during lactation such a cow would require nine per cent of her food extra for every 2 lbs. of milk. So, the Commission thought that the cows might starve if more milk was taken out of them than they could graze for. But, even at that time these milkers were not put to seeking all their requirements from grazing. They were given concentrates appropriate to their requirements.

In order to supplement the bulls, supplied by the Hissar farm, leases of tracts have been granted on favourable terms to some farms. These grant-receiving farms are also showing good work both in milk output and in their out-turn of bulls. (66)

243 Breeds of the Punjab: Things have changed fast since the Royal Commission left the shores of India. The other breeds of cattle of the Punjab have been forcing themselves into prominence. The Montgomery cow, now called Sahiwal, has come to be regarded as the best milk-breed of India. Her milking capacity has not, it appears, been fully tapped, although she has been recording 14,000 lbs. of milk in a normal lactation of about 300 days.

The Dhanni with its majestic sleek coat is being more and more appreciated for its speed and heavy draught-quality. The Bhagnari is of no less importance and the Rojhan, a sister type to the Bhagnari, is also trying to have its place of recognition for its draught-qualities, for its satisfaction with the poorest quality of fodder, and also for its requirement of lesser quantity of fodder because of its size.

244. Veterinary work in the Punjab: The progress in veterinary matters in the Punjab requires special mention.

An idea can be formed of it by comparing the position of 1920 with that of 1937, the period covering the working time of Mr. Quirke. He became chief superintendent of the Veterinary Department in 1921, and on the separation of his Department from the Agricultural Department, he became Director of Veterinary Services in the Punjab and held the post at the time of his death in 1938.

245. Progress in the Punjab upto 1938 :*TABLE - 11*

	1919-20	1937-38
No. of Veterinary Hospitals in the Punjab.	137	304
No. of outlying dispensaries. ... ..	...	1,200
No. of stud bulls.	1,352	5,370
No. of Cattle Fairs and Shows held.	35	252
Strength of non-gazetted staff for district work.	192	393
Strength of Gazetted staff.	15	36

— (*Agriculture & Live-stock in India. July, 1938*)

246. Veterinary department separated from agriculture : The separation of the Agricultural and Veterinary work has done much for the Punjab, according to Sir Arthur Olver. He pleaded during his period of service in India vehemently with the Central Government for separation of the two departments, because, in his opinion, a Veterinary Department tagged on to the Agricultural Department could not bring in that amount of undivided attention on veterinary and animal husbandry matters which they needed. Anyway, the official progress in veterinary matters in the Punjab has been exemplary. (108)

247. Indian cows & their possibilities : The coming into prominence of the Sahiwal cow opened up the possibility of pitting the Indian cow against the world-famous Ayreshire and the Friesian Holstein cows, the world's best milkers. The work was taken up in right earnest by scientific enthusiasts,

and the record of their endeavours is a noble one. The Sahiwal having given the incentive and inspiration, the experimental work carried out on the Sahiwal even outside of the Punjab is worthy of notice.

The Sahiwal was regarded by veterinarians as the purest milk-breed. But by closer scientific observation Matson has found that of four Sahiwal calves from pure-type parents only three came true to type, while many high-yielding cows cannot breed true. Breeding true comes out of the purity of the breed. The way to purify is one of eliminating the undesirables and of in-breeding, and then line-breeding. Such work is being conducted on the Sahiwal.

248. Organisational work in the Punjab : The organisational work that has brought the Punjab and her cows to the forefront in animal husbandry needs examination.

The general policy adopted for animal husbandry work on the improvement of live-stock was the distribution of improved sires and the castration of scrub animals, prevention of and combating of diseases etc. Vigorous work was going on in these directions, and by 1933 the work in progress was of a considerable magnitude.

In 1933 there were 288 veterinary hospitals for 23 million live-stock in the thirty-seven thousand villages of the twenty-nine districts, averaging 1 hospital per 128 villages. The veterinary assistants, under the guidance of their inspecting officers, were required to make thorough acquaintance with the

villagers and their live-stock within a 5 mile radius of the hospitals as centre. They were required to make surveys and keep reports for the inspectors' information. One of the duties of the veterinary assistant, attached to a hospital, was to keep a register of the District Board bulls and also keep a record of the details of all privately-owned bulls, and the number of castrations done from the centre.

249. Distribution of bulls in the Punjab : In the Punjab, the District Boards were buying the bulls from Government farms for distribution. They were buying bulls of 3 years age at the time at Rs. 252/- each. Out of 29 districts 20 were interested in receiving supply of Hissar bulls from the Government and the grantee farms. Montgomery bulls from grantee farms of that area were supplied to municipal areas and to special localities. Hissar bull distribution was concentrated in the canal areas where some degree of control for carrying out effective stock-improvement was possible.

The Dhanni bulls were allocated to their home tracts in the Rawalpindi, Attock, Jhelum and Shahpur districts in the northern Punjab and to the Dazzal cattle tract of the Dera Ghazi Khan district, as an extension of the Bhagnari country of the Jacobabad district of Sind. In the Dhanni tract a maintenance allowance of Rs. 8/- to 12/- per month was paid. In this tract fodder was insecure. The local zemindars are keen stock-breeders with a determination to succeed in grading up their breed. The people of this tract have great economic difficulties to contend against.

In the Dazzal area in the Dera Ghazi Khan District there was also a subsidy scheme in operation. The zemindars are stock-breeders, and against great difficulties strive to eke out their existence through cattle-breeding. The whole of the demand from the N. W. Frontier Province is met from the Dhanni tract in northern Punjab, while the demand from the south-western districts such as Multan, Muzaffargarh, Jhang and Dera Ghazi Khan are met from the Dazzal tract. The number of Hissar bulls under the supervision of the Veterinary Department was 3,400 in 1933. Many more bulls were needed, but the funds at disposal did not permit of any increase in the number ; sometimes old bulls which should have been removed are not removed for want of a replacement bull.

Hissar bulls are handed over to the headmen of villages for maintenance and taking care of. They are let loose after a time to graze and feed freely and remain with the village herd as common property. The villagers accept the bull as a valuable acquisition. But when the bull goes out of control and damages the crop unduly, then there is a reaction. The wildness of the bulls and the practice of keeping them free to roam about day and night was telling very much against their popularity, and neither the District Boards nor the Veterinary Department had funds from which to build shelters in brick and mortar for even a fraction of the number of bulls. The funds were meagre and the amounts allotted to animal husbandry was quite inadequate for the work.

250. Disproportion of District Board allocation :

As an illustration, the disproportion of the amounts allotted to different heads by the District Boards for 1930-31 is given below. The amounts are in lakhs of rupees.

Education	...	118	
District works	...	26·5	
Veterinary	...	4·07	} 7·1
Stock-breeding	...	3·03	
Public health	...	5·5	
Medical	...	25·3	

Probably education was being fed at the expense of stock-breeding and similar subjects. If this disparity in expenditure were corrected, the Punjab could have made yet more progress.

251. Trade in cows : There is a trade in the Haryana cow from the Punjab at Calcutta and Bombay. A commercial news-service is maintained between Rohtak and Bombay and Calcutta so that the dealers at both ends might know what was happening in the inter-provincial market.

Cattle fairs held by the District Boards and Municipal Committees numbered 339 besides numerous one-day Cattle Shows at important breeding-centres, where prizes and medals were given to encourage healthy competition amongst breeders. (199, 304)

252. Raising milk yields of draught and milk breeds : For raising the milking capacity of the cows of the draught-breeds without impairing their draught-quality, a Herd-book scheme for the Dhanni breed was started in 1938 in 5 selected places of

the tract, each in charge of a veterinary assistant surgeon, assisted by a stocks-assistant. 153 cows were registered upto March, 1940. A scheme for maintaining a herd-books for the Sahiwal breed was initiated in 1939 in 3 selected places. (108, 226, 320)

253. Milk recording by I. C. A. R. : Under the auspices of the Imperial Council of Agricultural Research and financed by it, 3 qualified milk-recorders were appointed for keeping proper milk-records in order to develop high milk-yielding strains in the home tracts of the Sahiwal and the Haryana breeds, in the Montgomery and Rohtak districts.

800 of the best Haryana cows were subsidised at a cost of Rs. 12,000/- so that they might be properly fed and served by improved bulls.

56 milk-recording centres were established in the Haryana tract in 1940.

The District Boards and the Municipalities had by this time framed rules against the letting loose of scrub bulls. The idea of floating cattle-breeding societies and of co-operative breeding societies had caught on. In one division, Ambala alone, there were 1,217 Civil Veterinary Department informal cattle-breeding societies with 15,060 members, having 26,303 cows. In addition, there were in this division 53 co-operative cattle-breeding societies with 1092 members and 1,563 cows.

By 1942 there were 3 milk-recording schemes in operation under the auspices of the I. C. A. R. in the Punjab, two for Haryana cattle and one for Murrah buffalo. Haryana in Bhawani Khara of the Hissar

District was inferior in milking-capacity to the Haryana of Beri in the Rohtak district as the following figures from the milk records will show. (488)

254. **Harianas in the villages.**

TABLE—12

	No. of Lactation recorded.	Average milk in lactation. in lbs.	Lowest yield lactation. in lbs.	Highest yield lactation. in lbs.
Bhowani Khara, (Hissar District)	21	1,650	791	2,970
Beri, (Rohtak District)	28	3,190	2,063	5,295

These results were natural, for, in the Hissar District most emphasis had been put on draught-quality and none on milch. Now, perhaps, things may change for the better even in the Hissar District.

In addition to the I. C. A. R.-financed schemes, Provincial ones were also in operation in the Punjab. Three for the Sahiwal are worthy of mention. Milk recording was in charge of a science graduate usually holding Indian Dairy Diploma. He was provided with stocksmen as assistants if a large number of cows were in register. A register was kept showing the number of animals and the names and addresses of the owners. The owners' premises were visited once a fortnight and the total milk yielded by each cow during 24 hours was recorded in a standard form for each animal. The particulars of the animal, such as names of the dam and the sire and other details regarding breeding and milk production, were entered therein. When the animal went dry her lactation-yield was calculated by a uniform method formulated by the I. C. A. R.

The milk-recording officer was also an adviser on feeding, breeding and management, on the necessity of the use of pedigree bulls and similar other matters. In fact, he was also a propagandist of the Veterinary Department. (65, 321)

255. The 10,000 lbs. milk club of India : This club was also operating in the Punjab. The report of certain cows of the Sahiwal breed of a grantee farm, the Jehangirabad Cattle Farm, is given below :

TABLE—13

Name & no. of cow.	Date of calving.	Milk yield in lbs.	Remarks.
Jalali J 73/2.9	14-4-33	7,176	calf unweaned
	27-4-34	7,335	,,
	16-5-35	11,721	,,
	21-12-36	11,568	,,
	21-5-38	10,144	,,
	28-7-39	9,470	,,
	3-11-40	6,236	,,
Naegas J. 56/2.0	4-2-34	9,602	,,
	13-6-35	5,085	,,
	8-7-36	14,010	,,
	7-1-38	11,699	,,
	10-3-40	Still in milk	,,
Nogni J. 28/1.2	1-11-35	6,697	,,
	25-1-37	7,690	,,
	27-4-38	6,380	,,
	9-4-39	6,135	,,
	29-10-40	14,692	,,

—(*Indian Farming* ; October, 1942). (180, 199)

256. Mudini—the famous Sahiwal prize-owner, owned by the Ferozepur Military dairy farm : Mudini has been winning the cup for the best cow in the All-India Cattle Show, Delhi, successively for three years. She won the cup for the best cow in the 3rd All-India Show in 1940, and again in the 4th Show in 1941. She won the cup in Milking competition with an average of 51 lbs. and was adjudged the best animal of the Show. In the 5th All-India Cattle Show, Delhi, in 1942, she again was held to be the best animal of the Show. She won the milking competition this time with $47\frac{1}{2}$ lbs in 24 hours. She also took four other prizes.

In closing this description of the 10,000 lbs. Club and the performance of the Sahiwal at farms and at the All-India Show, it is worth while to mention the change that has been wrought in the Sahiwal in the brief period of 9 years.

In 1933, Mr. Zal R. Kothawalla recommended the opening of Herd-Books for 6 important milk breeds (1) Red Sindhi, (2) Haryana, (3) Tharparkar, (4) Kankrej, (5) Gir, (6) Sahiwal. He added brief notes to his recommendation. The note on the Sahiwal ran thus :

“(6) Sahiwal—A medium-sized dairy breed which lost its importance due to its failure to meet the present-day agricultural requirements of the country, as the male animals are too slow and practically useless for work purpose.”

The Sahiwal cow cannot be said to have lost her importance today as she is occupying the first position

amongst milch cows, and the Sahiwal bullock also is not regarded as useless for work purpose. The Sahiwal bullock is now regarded as a slow but heavy-



Fig. 25. H. E. The Viceroy examining Mudini, the champion of the Show.

(Indian Farming., Vol. III, No. 4)

working useful animal. What it lacks in speed it makes up in volume.

257. The other side of the Punjab picture : The reader has got an idea of the excellent animal husbandry work going on in the Punjab. But this is one side, the official and the institutional and research side of the work. The village side of the work in spite of all the dispensaries and propaganda, looks dismal in contrast. The village enquiry regarding cattle and the production and consumption of milk in seven Breeding Tracts of India of 1936-37 included the Montgomery and Hariana tracts also. In this enquiry both the Montgomery and Hariana breeds in their village homes came out as poor animals in comparison with the breeds in the hands of the Government Dairy Farms or the Grantee Dairy Farms, which were dealt with in the preceding pages.

The average milk-yield in the villages in a lactation was found to be low. The Sahiwal average was found to be 1,343 lbs. and of the Hariana only 986 lbs. in the villages as against the typical average yields of the farm-bred improved cattle, which are 7,000 lbs. for the Sahiwal and 3,634 for the Hariana (*Wright's Report. (1937)*,—Table 31). (219, 236, 278, 303, 372-'76)

258. The Montgomery tract : The enquiry referred to (I. C. A. R. 8-22) was limited to the Montgomery District. This District lies between the rivers Sutlej and Ravi. 60 villages were selected for enquiry, and in each village 20 holdings were chosen at random.

No. of persons per holding.	6.9	
No. of cows per holding.*	1.0	} 3.1
No. of she-buffaloes per holding.	2.1	
Average milk yield per day per cow.	4.72 lbs.	

22.5% of the population of this tract did not produce any milk. The mean per capita production was as high as 26 ounces of milk including both cow and buffalo milk.

Montgomery is a canal-colony area. This area in pre-colony and pre-irrigation days was full of grazing ground and was populated by the tribe called *Junglis*. Now there is a mixed population of the *Junglis* (hereditary graziers) and settlers from other districts of the Province. Agriculture and trade and industry, based on agriculture, are the main occupation of this people. On account of colonisation, pasture grounds have been reduced. The Dipalpur *tehsil* of the district comprising 541 villages is the chief area for breeding the Sahiwal. This area is inhabited mostly by the *Junglis*. (72, 202, 223, 266, 287, 302, 336, 344, 1061)

259. The Jungli : The name *Jungli* may convey an idea of an ill-clad, unkempt people. But it is not so. The *Junglis* of Montgomery are an aboriginal tribe who used, till recently, to lead a nomadic life. Their principal occupation was breeding cattle in which they were experts. Owing to the opening of the canals, the life of the *Junglis* was seriously affected ; they had to take to agriculture. Although outwardly they may be leading a life of greater security, they cannot forget their lost pasture or the fine horses and cattle they possessed which had mostly to be disposed of on account of the shortage of pasture. During the last few decades, things have changed very fast for them, and they still think that their freedom has been restricted and they

have been forced to handle the plough. The *Junglis* keep their houses and house-hold articles scrupulously clean. Such are the people who were mainly



Fig. 26. The Jungli Cultivator.

(Agriculture & Live-stock in India., Vol. VIII, Part I)

responsible for keeping the Sahiwal breed pure, and handing it down to the present times. (72, 223, 1061)

260. The Sahiwal disfavoured in her own land : For reasons we have repeatedly come across, for reasons of greater care being given to the she-buffalo, she gives more milk and is, therefore, greater prized. In the Montgomery District too we find the predominance of the buffalo, they being double in number to the cow. It is an irony that the Sahiwal which in Government farms do compete with the buffalo in all points to its advantage, is regarded with disfavour in its own home-land where the buffalo is preferred to her. The reasons are plain enough. The buffalo continues to lactate without much difference whether her calf lives or dies, and the male of the buffalo has mostly to die. The same treatment of eliminating the male-calf cannot be accorded to the male calf of the cow in village homes. If that treatment were accorded, and if the calf was allowed to die, the milking of the cow would cease. The rearing up of the calf of a cow must cost 300 to 400 lbs. in milk, fed to it during a lactation. And the saving of this amount in the case of the buffalo is a great inducement for the villager to keep a buffalo for milk rather than a cow. The fact that a buffalo can be milked without her calf has led to the practice of the starving off of its undesirable and uneconomic male calf. The practice is general and the Montgomery tract is no exception to it. (Chapter IV : 72, 223, 1061)

261. Cows neglected, buffaloes cared for in Montgomery : "The female cow-calves are very poorly treated being just allowed to exist while the male buffalo-calves are disposed of at birth. The female

buffalo-calf and the male cow-calf, which have a higher market value, are, however, better cared for. "Owing to the lack of any systematic method of feeding in accordance with individual requirements and a gross over-stocking of the area, the majority of the cow-calves generally remain stunted in their growth. Weaning is done generally when the calf is 8 to 10 months old. After weaning they receive the same treatment as the adult cattle, good, bad or indifferent, according to the interest and resources of the owner. Usually they (the cow) remain under-nourished as the rest of the stock."—(*Seven Breeding Tracts Enquiry*.—P. 75) (72, 109-'27, 223, 1061)

262. Buffalo is the dairy animal in Montgomery :
While the above observation occurs about the cow in the Montgomery tract, in the same report (I. C. A. R. 8-22) the following observation is made about the buffalo :

"For dairying purpose, the female-buffaloes of the two famous breeds "Ravi" and "Nili" of this district have almost over-shadowed the Montgomery cow. They are greatly liked by the zemindars, and on the whole quite carefully reared. Well-selected male buffaloes are being kept for breeding purposes in many of the villages."

Such is the treatment meted out to the Sahiwal cow in her own home when in the year of enquiry (1937) Mr. Wynne Sayer was visualising in no distant future to set her up as an all-round 10,000 lbs. herd cow, and when in 1937 a Sahiwal cow "Naegas" was

yielding 14,000 lbs. of milk in addition to maintaining her calf in the Jehangirabad Cattle Farm.

This poor consideration was being meted out to the Sahiwal cow in her own home when "people all through the Province are becoming conscious of the Montgomery breed, and as a consequence their demand is growing daily." (72, 109-'27, 223, 1061)

263. Dipalpur tehsil for Montgomery breeding :
The District Board of Montgomery has chosen the Dipalpur *tehsil* of the district, which is nearly one-fourth of its area, for fostering the Montgomery breed.

"...There are 65 district-board bulls of pure Montgomery breed concentrated in Dipalpur area for breeding purposes in an attempt to retain this portion of the district, where the inhabitants are mostly *Junglis*, on Montgomery cattle breeding."
—(*Seven Breeding Tracts Enquiry*—P. 74)

A poor consideration as compared with the 193 Hissar bulls distributed in the same district !

"...The economic resources of the zemindars do not encourage them to take as much interest in the pure Montgomery breed as desired...." (*Ibid*)

That the Montgomery villager produces 26.11 ounces of milk per head per day and consumes 15.53 ounces of milk and milk equivalent per head per day should not lull us to thinking that all this milk is to the credit of the Sahiwal or the Montgomery breed. For, where a Montgomery cow yields 4.70 lbs. of milk per day a buffalo in the same tract produces 8.24 lbs. per day. Then again, the buffalo is 50 per cent at any time on lactation against 40 per cent of the cow. Along

with this has to be considered the fact that for every cow, 2 she-buffaloes are maintained by the villager. On this basis the fraction of milk attributable to the Montgomery cow is less than one-fourth of the total milk production in the tract. (72, 223, 1054-'055, 1061)

264. Sum-total of propaganda effect in the Punjab : The *ryot* never felt so poor as he does today and, therefore, is found to be in an absurd position. The real cause of his poverty, the economic cause of it, has to be solved so that he may find himself on solid ground and readjust his attitude to the cow, to the buffalo and to all and sundry. It is poverty that makes it possible for a *ryot* of the Sahiwal tract to neglect his cow, and despite all the very good object lessons supplied by the veterinarian, the *ryot* remains stoic and unaffected. All the Provincial veterinary departments in India are spurred on to organise propaganda for the improvement of the condition of the cattle of the *ryots*. And the Punjab being the premier Province in animal husbandry matters has got a well-equipped, active and able propaganda machinery. The sum-total of the propaganda in the Punjab is to be judged by the attitude, for example, of the Montgomery *ryot*, the *Jungli*, who gets only thirteen hundred odd pounds of milk per lactation and only 2 seers of milk daily from his Sahiwal.

In spite of all the best that the Punjab Government has been doing for the *ryot* he remains unaffected. He feeds his female-buffalo calf well and neglects the female calf of the cow, and fails to develop the priceless asset he has in his Sahiwal. It is for us to find out

the cause of this callousness of the *ryot*. We know that he is not always callous, that he is very responsive to improved methods which is within his means, and which involves no risks for him. Economically he is a clever person. Why has not the Government been able to rouse the Montgomery *ryot* to take such care of his cow as he does of the buffalo ? (18, 398, 403)

265. Government methods of breeding leaves the cultivator unaffected : The Government is not trusted ; it is in effect foreign to him. The Government methods of cattle improvement are beyond his means. His immediate income counts hundred per cent with him. Long-distance improvement or deterioration of cattle are matters which he understands, but he is helpless. He needs help, and propaganda is not the help that he needs first. Propaganda can be no substitute for the help he needs. The village economics upon which he built his life and social order are violently disturbed, and he has been thrown off his feet by the Government interfering with his habits of life, interfering with his cottage industries, with his training and with the very basis of his education. The root cause lies there. The Government should, in addition to other measures, provide security also to the cultivator breeders in the form of fair milk prices and fair prices for their cattle. Attempts at improvement, without the above considerations, cannot be of much use. (18, 398, 403)

266. The Hariana tract : This tract consists of Hissar, Rohtak, Gurgaon and Delhi districts and also a part of Karnal District in the Ambala Division. The

rainfall is 18 inches in the year. The soil contains plenty of lime. The land is fertile but is dependent on the rainfall. The land per holding is 12·8 acres, which is half of the Montgomery holding, while the number of persons per holding is the same as in the Montgomery tract, being 6·8. This tract is, therefore, doubly populated as compared with the Montgomery tract.

The same factor that operated in the Montgomery District also operated here to bring about very considerable shrinkage of pasture-land which affected the quality and number of the cattle of the Haryana breed. "...It no longer pays to breed cattle in an area where commercial crops, such as wheat and cotton, can be grown under irrigation with greater profit to the local zemindars. (*ryots*)."

* (202, 258, 287, 302, 321, 336, 344)

267. Small profits of cattle breeding : "...The profits from cattle-breeding are very small, and it is adopted as an industry by the small land-owner as a means of eking out a living for himself. No doubt, the cattle are the zemindars' treasury here, and he puts all his savings into them ; yet the melancholy fact remains that breeding does not pay or only pays poorly."

These two sentences from the Report of the Haryana Tract Enquiry make strange reading. The tract is irrigated, and has valuable commercial crops,

* In the Haryana tract also the buffalo problem is distressing. The Seven Tracts Enquiry mentions about the differential treatment to cows and buffaloes.

such as cotton and wheat. The pastures are torn up and cultivated to yield crops which are more profitable. And yet the *ryot* is said to be so poor as barely to be able to eke out a living for himself ; that he regards cattle as his wealth, and yet it does not pay him to take to cattle-breeding. If irrigation and better cultivation etc. has left the *ryot* poor, and if despite Government propaganda cattle-breeding does not pay him, then where lies the glamour of all the Cattle Shows held throughout the Province ? Of what use are the irrigation canals and the possession of the Haryana breed to him, if he is still to struggle on just for a living ?

268. Pasturage in the tract : "Cattle are allowed to keep themselves by grazing as long as possible and stall-feeding is, as a rule, only resorted to when the grazing and stubbles fail. In a good monsoon year there is sufficient grazing for nearly three months—July, August and September. Some of the good grasses indigenous to the tract are *Dub* (*Cynodon Dactylon*), *Dilla* (*Cyperus tuberosus*), *Makra* (*Eleusine aegyptiaca*), *Bhurit* (*Cenchrus echinatus*), *Anjan* (*Pennisetum cenchroides*) *Swank* (*Panicum colonum*), *Palwan* (*Andropogon annulatus*). The crux of the situation is that every common pasture is uncontrolled..... and every one in the village can graze as many cattle as he pleases on the village pasture. . . . "

—(*Seven Breeding Tracts Enquiry*.—P. 78-'9)

269. Other breeds : There are other breeds in the Punjab besides the Montgomery, the milch-breed,

and the Hariana the "dual purpose" breed. Dhanni, Dazzal and Bhagnari are the other draught-breeds, and they have been described in the Chapter on breeds (Paras 63, 74). Another breed that deserves mention is the Rojhan. It is a draught-breed of hill cattle and is a sort of sister breed to the Bhagnari.

270. **Rojhan cattle :** The Superintendent of the Civil Veterinary Department is keen on this breed on



Fig. 27. Rojhan Bullock.
(Indian Farming., Vol. III, No. 2)

account of its efficiency as also its capacity for work under adverse conditions of feeding and weather. This is a breed particularly suitable for the poorer *ryots* who have to get the utmost draught out of the smallest feed. While writing on the Rojhan cattle the Superintendent of the Civil Veterinary Department, Punjab, observed in the *Indian Farming*, February, 1942 :

"A good deal of work has been done on draught type cattle in the Punjab where the famous Hissar, the Dazzal, and the Dhanni breeds vie with one another for recognition as the ideal draught-type. Well-bred, handsome and imposing in their looks, they are really an ornament for any agricultural holding. In canal-colonies and in areas under intensive cultivation they do enormous work. But there are large areas in the Province where the work is not as heavy, the zemindar not so prosperous, and the fodder resources not as plentiful. If brought to such parts they would become a liability rather than an asset. . . ."

271. Mr. Pease's observations on improvement of breed of cattle: With a similar point in view Mr. Pease in his classical report on the breeds of Indian cattle observed: "if it be desired to improve the breed of cattle in the various districts we must always keep these objects in view, viz: (1) to produce an animal of the same class which is naturally found in the district but stronger and better; and (2) to produce one which will subsist on the available fodder."

The Rojhan cattle seems to meet this requirement for very large areas in the Punjab. The home of the Rojhan breed is the Dera Ghazi Khan District. The breeders dwell in a tract where cultivation is uncertain owing to the vagaries of the river Indus in the east and the hill torrents from the Sulaiman hills in the west. In this area grasses are inferior,

and the land is mostly waste. Out of these circumstances has developed the migratory character of a section of the people of the above district which move in search of pasturage with its herds and flocks.

The name Rojhan comes from the Rojhan *ilaqua* of the Sukkur District (Sind) where the Masuwah channel takes off from the Indus. The Rojhan is regularly bred there. They are of a very hardy type, being strong and sturdy but much smaller and more clumsy than those of the Bhagnari breed. They are prized for work on the wells of the riverain tract of Multan, Muzaffargarh and the Derajat. They are also used so far away as Sialkot, Gujranwala and Amritsar. They are extremely hardy and thrive on any kind of fodder.

The breed is distinguished by its red colour, splashed with white varying from a mere star or a mark on the dewlap to big patches all over. The animals are of medium or small size, being about $47\frac{1}{2}$ inches average in height and 53 inches average in length. They are very active, nervous but spirited animals. 141, 508, 503, 506)

272. Breeding in the United Provinces : The United Provinces is a very large Province, being the largest in area of any single Province in India. It is a long strip of country continuous to the Punjab on the west and Bihar on its east, the Himalayas on the north and several Indian States on its south, such as Alwar, Bharatpur, Gwalior and Rewa. The border lands of this vast Province

ake of the character of the Provinces and States surrounding it, while the Himalayas and the Nepal *terai* give the special characteristic of forest and grazing land which is a feature of this Province.

Naturally, the western tract possesses cattle and people which are of the same category as those of the Punjab. The Haryana tract of the Punjab is continuous with the Haryana tract of the U. P. The Muttra District of the U. P. adjoins the Gurgaon District of the Punjab ; similarly, Meerut, Muzaffargarh and Shahranpur, Deradun of the U. P. partake of the character of the Ambala Division of the Punjab, and all have cattle more or less of the Haryana breed. In fact, Muttra has the largest cattle breeding farm in the U.P., breeding the Haryana cattle at Madurikund.

273. The sown area of the U. P : It is 36 million acres, the largest sown area of any Province in India, and naturally it has the largest number of bovine animals connected with cultivation and milk production. According to the census of 1931, the U. P. had 10 millions bulls and bullocks, 6 million cows and 4 million she-buffaloes. These numbers are significant and express the character of the Province.

It is one of the *ghee*-producing tracts of India. The other *ghee*-producing tracts are the Punjab, Bombay and Madras. The peculiarity of these tracts is the larger proportion of buffaloes as compared to the cows.

274. Table of the number and ratio of cows and buffaloes in Provinces :

TABLE - 14

Province.	No. of cows in millions	No. of she-buffaloes in millions	Ratio of the buffalo to 100 cows.
1. Punjab.	2·6	3·0	115
2. U. P.	6·0	4·2	70
3. Bombay.	2·0	1·2	60
4. Madras.	5·9	2·8	47
5. Sind.	0·8	0·3	37
6. Bihar & Orissa.	5·7	1·6	28
7. C. P.	3·1	0·8	26
8. Assam	1·7	0·19	11·1
9. Bengal.	8·2	0·27	0·33

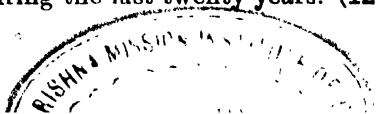
Per 100 cows the Punjab has 115, the U. P. has 70, and Madras 47 she-buffaloes. And these are the principal *ghee*-making Provinces. The U. P. has, however, the largest number of she-buffaloes with its 4·2 millions, closely followed by 3 millions of the Punjab and 2·8 millions she-buffaloes of Madras. (127)

, 275. The cow & the buffalo milk ratio : From these and similar figures about the ratio of cow-milk to buffalo-milk, the Government came to the conclusion that the she-buffalo was the milch-animal of India, and the cow played second fiddle. Taking India as whole these deductions cannot be disputed. But if the matter is judged in the light of the natural conditions in India, it is not true. (109-'27)

276. Place of ghee in popularising buffalo : On account of the cheap and quick transport of *ghee*

now made possible, the trade in buffalo *ghee* has been built up in recent years. But it must be admitted that it has not got a solid bottom. Under the present artificial conditions the she-buffalo, indeed, is the milch-animal, but naturally it is not so, and may not and should not continue to be so. The buffalo has been pushed to the forefront in the several provinces in an unfair competition for immediate gain and for distant transport of *ghee*. This rivalry for a high place in the milk work by the she-buffalo is entirely a creation of the present times. There were buffaloes in the land all along and there will be when the present unnatural state ceases, but in a normal condition the exaggerated proportion as between the cow and the she-buffalo cannot continue. I say abnormal, because the she-buffalo stands upon adulteration in the milk trade already referred to, and because of her capacity to milk in the absence of the calf, and because of the fact that the householder feels no compunction to let the male of the buffalo starve to death.

It is all for immediate gain, a gain that can be felt at the moment but at the cost of much that is prized in the human march towards civilisation. It has been mentioned that the buffalo eats much more than the cow and that the she-buffalo is much more cared for by the *ryot*. In spite of all this care and feeding and in spite of all the apparent profits that the she-buffalo brings, her number has remained practically constant during the last twenty years. (127, 280, 1125, 1126)



277. Cows and she-buffaloes in India in thousands :

	1918.	1938.
Cows	36,079	37,052
She-buffalo.	13,234	14,967

The number of cows has varied in 20 years from 36 millions to 37 millions, and the number of she-buffaloes has varied from 13·2 millions to 14·9 millions. (127)

278. Treated like the cow, the buffalo might have been extinct : It is gathered from published reports that in times of scarcity the cow is regarded as a drag and is treated accordingly, whereas the she-buffalo is more than usually cared for in those times, because of the money that she brings. With all this the she-buffalo has remained numerically where she was 20 years ago. Now, imagine if the reverse were the case. If the cow was cared for as much as the she-buffalo is, and if the she-buffalo had met the same treatment as the cow now receives, I venture to suggest that under the cruel treatment meted out to the cow, the she-buffalo would have been extinct. The cow, even under the miserable treatment, stands by us and protects us, and gives us bullocks to serve us. How much more milk in total would she not have given to India, every year, if the same treatment were accorded to her as is accorded to the she-buffalo? Again, consider the enormous economic loss in keeping the cow stunted. A stunted cow gives rise to an inferior bull and an inferior bull deteriorates the stock. This is what has been going on. (109-'27, 219, 236, 257, 303, 372-'76)

279. Disastrous result of pitting the she-buffalo against the cow : Undoubtedly there would have been less degeneration of the cow and consequently of bulls and bullocks in the Punjab, the U. P. and Bombay, if the she-buffalo were not artificially and cruelly foisted against the cow. While the *ryots* in the Punjab, the U. P. and Bombay get a few coppers additional by keeping the she-buffalo, they injure the very backbone upon which agriculture and rural transport depends. It is for the Government to enter into the problem with foresight and discourage buffalo-rearing to the detriment of cow-rearing.

And yet the very reverse has been happening. The men at the head of affairs have taken it for granted that India is to depend for her agricultural draught-power on the cow and for milk on the buffalo. This has been the complacent note in the Report of the Royal Commission, and this has been the tone in all official talks since, despite the protests of men like Capt. Littlewood of Madras and Sir Arthur Olver, late Animal Husbandry expert. Responsible officials and advisory economists should take note of the position that the present place given to the buffalo by the *ryots*, for reasons detailed above, is detrimental to the interests of India, and that the official policy should be to protect the cow against the unfair and short-sighted competition in which the buffalo has been allowed to enter. (109-'27)

280. Ghee—an article of major trade in U. P. : Because of the buffalo, the very extensive *ghee* trade, centered round some of the principal towns of the

U. P., exists. From Aligarh and Meerut at the far-western end of the Province to Gorakhpur and Ghazipur at its extreme east the *ghee* trade is a major trade. Practically all this is from the buffalo. Gorakhpur at the eastern end is only *gorakh* (protector of the cow) in name ; it does not know how to protect the cow against onslaughts upon her. But a change has been coming over, and defenders of the cow have entered the field today at Gorakhpur who feel that she is being cruelly treated partly because of the buffalo. (276, 1126)

281. The breeding farms of a Madurikund, U.P. : To come back to breeding in the U. P. At the time of the Royal Commission (1927) there were two cattle-breeding farms. One at Madurikund near Muttra, and the other at Manjhara in the Kheri district. The one at Madurikund had an area of 1,400 acres, and Hissar and Murrah buffaloes were bred there. The Manjhara farm had 550 acres with a scheme for an additional 2,000 acres. Here three kinds of stock were kept : Sahiwal, Kherigarh and the Murrah buffaloes.

From experience it was found that the attempt to grade up the breeds could not be successful if a large area was taken up and catered for with only a limited number of bulls. Therefore, the alternative of intensive work in a small area was taken up, and two areas were chosen and adequate provision for inspection was made.

At that time an estimate was made that for a farm to produce 80 to 100 bulls annually a sum of

Rs. 2 lakhs was necessary for capital expenditure, Rs. 23,000/- annually for recurring expenses, when the farm reaches full production. This meant that each bull would cost about Rs. 250/-.

282. Bull policy and grading up operations about 1933 : Later on, the U. P. Government changed its policy and proposed to distribute the bulls free. Grading up operations were in full swing by 1933. The following Table is instructive :

TABLE—15
Number of Bulls in U. P.

	No. of bulls issued.	Total no. of bulls in the stud in the Province.
1923	46	239
1924	72	301
1925	79	312
1926	100	374
1927	262	597
1928	635	1,186
1929	815	1,947
1930	568	2,341
1931	639	2,731
1932	555	3,015

Up to 1932 the two cattle-farms had only 1,800 acres with which they had started. But in that year two new breeding-farms were started with a combined area of 6,000 acres. The breeds were Haryana, Ponwar, Kherigarh, Sahiwal, and the Murrah buffaloes. The Haryanas were purchased from the Punjab, while

the Ponwar and the Kherigarh were purchased from professional breeders in the *terai* who had been maintaining a careful standard of breeding and had considerable uniformity in their breeds.

The Government was in search for a method of minimising the expense for supplying bulls. A method in keeping with the tradition of the country was hit upon. It was to regard the Government bulls in the same light as the *Brahmani* bulls. The Government decided to purchase cheap young male calves of 2 years or about, and distribute them at still cheaper rate to the *ryots*, instead of giving free, as was the practice up to that time. It was decided to charge Rs. 30/- for a purchased bull and Rs. 40/- for the stock bred on the Departmental farms.

This idea caught on. The villagers found the young bulls more tractable and ungrudgingly took to maintaining them in the same way as the *Brahmani* or dedicated bulls had been maintained.

“ Generally speaking, very few cattle-owners have sufficient cows to make it worth their while to keep a stud bull on their account. For this reason the stud bull is looked upon more as a sort of public institution, than as something which should be provided through private agencies. The Hindu custom of dedication has further more encouraged this idea, and breeders grown accustomed to the idea that the provision of stud bulls is the concern of an outside agency. The idea that Government should assume this responsibility is, therefore, more understandable

to them than any suggestion that such provision is a concern of their own.

".....In my opinion cattle-breeding must follow this line of development in this country. Cattle-breeding development schemes must be national or provincial in scope and character, and their initiation and direction must remain the responsibility of the Governments concerned.

"The predominating idea, that the stud bull is a sort of village public institution, the dependence which is being already placed on this Department in this Province in regard to stud bull supply, indicate that there is much in the situation already to favour development on these lines... conditions appear to favour the assumption of this responsibility in regard to the development of cattle-breeding on a Provincial basis by Government itself. This object should be kept in mind when cattle-breeding schemes are framed. Such schemes should take into account this ultimate scope of the operations involved, and as suggested above, should be framed to become to some extent self-supporting within a reasonable space of time. Schemes should be accompanied by financial measures, which will provide the necessary funds commensurate with the scope of the operations and will guarantee continuity to the breeding work. The importance of this aspect of the question has not, in my opinion, been fully appreciated. (141-'42) 283. U. P. "Removal of scrub bulls": "Where the Department's stud bulls have been issued the

removal of non-descript scrub bulls has not presented very great difficulties. As soon as the superiority of the progeny of the Government bulls has been demonstrated, many villages have made their own arrangements for the removal of such bulls. Sometimes the Department is asked to give assistance, and when an application, signed by leading men of the village, has been received to the effect that certain bulls are to be removed, these are taken away, castrated and sold. Though several hundreds have been so disposed of, progress has been limited by the staff available for the work. In those tracts where castration is not generally practised, the problem is a little more difficult, but my opinion is that so long as there is an agency which will supply a superior class of bull for use as a stud bull, villagers will do all they can to limit the breeding by inferior animals, and will co-operate in a scheme of castration or removal which may be introduced. The large number of applications which are received from villagers where the Department's bulls are located, indicates that there is a demand for assistance in this matter.

“Men trained in the use of bloodless castrators are required in villages, and I suggest that the Veterinary Departments arrange to carry out village demonstrations in the use of bloodless castrators, and that arrangements be made to make these instruments easily available to villages either through Panchayat funds or from funds from

other sources.”—(Note by Mr. C. H. Parr. *First meeting A. H. Wing*, (1933)—P. 156). (142)

284. Improvement makes fair progress in U. P. :

With the out-look set out above it can be easily understood that cattle improvement was making comparatively fair progress in the United Provinces. The Veterinary Department had struck a real note of understanding of the people and their traditions. There is both sympathy for and appreciation of the sentiments of the people which go a great way in making any Government measure popular, and the U. P. Government had done that. I believe that in that Province the Government has been able to penetrate to the villages more successfully with their appreciative outlook than they could have done with mere propaganda. I have mentioned that there are two classes of cattle improvement work—one official work carried out in the Government-owned-and-controlled farms, and the other popular work which touches the lives of the villagers. Even in so vital a matter to village life as cattle improvement, Government mostly fails to touch the villagers. But it appears that the U. P. Government had an instrument in their hands by way of sympathetic understanding of the people. A high-nosed patronising complex, however, is common in Government Departments, in contrast to this, even in propaganda meant for bridging the gulf between the Government and the people in agricultural matters.

285. Provision for veterinary work in U. P. :

Cattle improvement has been going on apace in the

U. P. after 1933. It was reported in 1930 that the Government had provided 4 lakhs of rupees for veterinary work in addition to the usual provision of the budget for the Veterinary Department. A Provincial Board had been established to advise on matters connected with animal husbandry and agriculture. In that year 250 stocksmen were to be trained to work under the Veterinary assistant-surgeons in charge of various rural dispensaries.

286. Bull policy after 1939 : Previously the U. P. Government had been charging Rs. 30/- to Rs. 40/- for supplying bulls. By 1939, the Government developed and put into operation the scheme of selling young bull-calves still cheaper and bring back the old bulls when these became useless. At the commencement, the *ryot* paid Rs. 22/- for a young bull, which remained Government property but was handed over to the village Panchayat for breeding. When the bull was old the Government brought it back and received Rs. 15/- even then, as its value. So that the Government realisation on account of the bull was 37 rupees, and something over this had to be spent in buying a new bull calf.

Up to 1935-'36 the provision for the purchase of bulls was Rs. 25,000. In 1936-'37 Government raised it to Rs. 50,000. These bulls were purchased mostly in the Punjab. In 1939 there was provision for the purchase of breeding-stock worth Rs. 1,50,000/- including Rs. 30,000/- grant from the Rural Development Fund, for the purchase of good cows.

BULLS ISSUED : Annually 450 to 600 bulls were issued prior to the drive initiated by Lord Linlithgow.

In 1937, 700 bulls were issued ; 900 in 1938 ; and the estimate for 1939 was for issuing 1,200 bulls. The object aimed at in 1939 was an annual issue of 2,000 to 3,000 bulls. By this time registration of pedigree milch herds had commenced in the villages of the Muttra District. (141)

287. **The Kosi tract enquiry of 1937 :** In 1937 the enquiry into the Kosi breeding-tract was confined to the Haryana area or the western part of the Province. It forms part of a western dry tract, the cattle of which are of the best type available in the Province. "In districts outside this area, preference is given to the keeping of she-buffaloes for milk production."

In tracts adjoining the *terai*, large herds of cows are kept for the supply of male-stock for agriculture. These breeds can produce only sufficient milk for their calves. The cattle of the eastern and north-eastern districts of the U. P. are of a poor type. (202, 258, 266, 302, 315, 336, 344)

288. **Cattle-breeding tracts in the U. P. :** The U. P. may be divided into 5 cattle-breeding tracts.

"(1) The dry western tract (rainfall 20-30 inches) which includes the area west of the Ganges stretching from Cawnpore to Saharanpur, including 14 districts which form part of the Agra, Meerut and Allahabad Divisions.

"In this tract good types of cattle, sheep and goats are to be found, and the soil and climatic conditions of the tract lend themselves to improvement being effected in the existing types.

“(2) The central humid tract (rainfall 30-45 inches) consisting of the highly cultivated areas of parts of the Rohilkhand, Lucknow and Fyzabad Divisions. In this tract only animals of moderate size and mediocre efficiency in draught and milk are produced, and better classes of animals, if introduced, tend to degenerate.

“(3) The Terai tract, situated at the foot of the Himalayas (rainfall 45-65 inches). This tract includes areas where grazing is in abundance ; but only small types of draught-cattle can be raised. This tract has no cattle or buffaloes of milk-type, and better types of cattle degenerate rapidly.

“(4) The Bundelkhand area of many different soil formations, where types vary noticeably with the different types of soils.

“(5) Hill tracts which can produce only the poorest and smallest types of cattle, and where cattle from other tracts tend to rapid degeneration.

“Within the above tracts, however, there are to be found some particular areas, which though situated in a tract where generally poor types of cattle are raised, are favoured in some way or other by suitable soil and fodder conditions and are, therefore, able to produce within this circumscribed areas, cattle much superior in type to the general type of the tract. (141)

289. Relation between soil and cattle : “It is now generally recognised that there is close relation between the types of soil of a tract, and the types of cattle and other domestic animals that can be raised

on it. The cattle are dependent on the fodders and agricultural by-products of the soil on which they are raised. Any deficiencies in the soil must affect, in some way or other, the composition as well as the quantity of fodder, etc., which it produces, and this must be reflected in the animals bodies which are built up on those fodders and agricultural by-products.

... ..

"Above, the Province has been divided into 5 tracts. In only one of them, namely, the dry western tract, can cattle of good type and efficiency be raised on ordinary fodders without special feeding; but even in this tract, experience has shown that the cattle benefit by the additional feeding of mineral salts. In this tract improvement of type can be easily effected if selective breeding is accompanied by improved feeding. But cattle from this tract degenerate if transferred to any of the other tracts. Cattle from the other tracts, on the other hand, will improve when brought into this tract." (Note by Dr. B. K. Mukherjee. *3rd meeting, A. H. Wing, (1939)*—P. 300-'01) (181)

290. Cattle-breeding in Bombay: At the time that the Royal Commission was sitting in 1927, there were two cattle-breeding farms, one at Chharodi in north Gujarat, another at Bankapur in the south Marhatta country. The Chharodi Cattle-Farm had 2,300 acres and 200 Kankrej cows and the Banakpur Farm had 50 Amrit Mahal cows. The Kankrej breed was regarded at that time as an essentially draught-

breed, and the Royal Commission was most anxious that any attempt to put more milk into the type should not interfere with its draught qualities. These fears were unfounded and the Kankrej breed today is firmly regarded as a dual type cattle producing sufficient milk.

291. Kankrej & Hariana cows : At the enquiry of 1937 it was discovered that the Kankrej breed is equal in its performances to the Hariana, the former giving in average of 920 lbs. of milk per lactation as against 980 lbs. of the Hariana in the hands of the villagers in their native tracts. Under care and management in the Government farms also, the two breeds of Kankrej and Hariana are giving similar milk yield. The milk yields of the Kankrej vary from 2,000 lbs. to 4,000 lbs., and in rare cases to 5 or even 10 thousand pounds in the Government farm of Chharodi in north Gujarat. The milk yield of the Hariana also shows similar figures—2 to 7 thousand pounds per lactation in the various Government farms of the Punjab. To be more exact, the average of 54 Kankrej cows was 3,159 lbs. per lactation as against the average of 3,426 lbs. of 81 Hariana cows. This was the position in 1937. But in 1927 the facts placed about the Kankrej before the Royal Commission justified their observation as under :

“...In many draught-breeds, there are not a few individual cows which have the full characteristics of the breed and are at the same time fair milkers. That this is true in the case of one breed at least is proved by the experience on the Chharodi farm with Kankrej cattle which are essentially fine

draught animals. Five years' selection has resulted in raising the annual average yield from 438 lbs. per cow in a herd of 100 animals to 1,330 lbs. per cow in a herd of 93 ; both figures of yield are in addition to the supply for the calf which is estimated at about 450 lbs. .."—(P. 217)

"...If systematic selection resulted in the raising of the average production of milk by Kankrej cattle to some such yield as has already been reached at Chharodi, not only would there be a great gain to cultivators, but an improvement likely to be maintained would have been effected...."—(P. 218). (67)

292. Table of milk yields of the Kankrej (1937-38):

That was the condition of the Kankrej in 1927. The milk-yield had gone up in the dairy farm from 438 to 1,330 lbs. And in the next 10 years it has further gone up to the average of 3,159 lbs. The figures for the Kankrej obtained in 1937, as recorded by Kartha in the Milk Records of Cattle in Approved Dairy Farms in India (1937-'38) published in 1941 (I.C.A.R. 8.36) would be interesting.

TABLE—16

Milk yield of the Kankrej

Lactation yield	No. of cows	Percent.
2,000—3,000 lbs.	25	46·3
3,000—4,000 lbs.	17	31·5
4,000—5,000 lbs.	10	18·5
5,000—6,000 lbs.	1	1·9
6,000—7,000 lbs.	1	1·9
Total ...	54	
Average yield ...	3,159 lbs.	

293. Bull policy of the Bombay Government in the past : About 1923 it was already apparent to the Bombay Government that by the distribution of a few bulls here and there no great effect could be produced on the improvement of the cattle. The Bombay Cattle Committee of 1923 came to the conclusion that approved bulls should be placed in a few selected areas most favourable for cattle-breeding. In this way, when the stock in the selected areas attained sufficient purity, bulls would be selected from them for general use. The Bombay Government approved of the resolution in the Cattle Committee report, but added that additional farms for supplying bulls to the selected areas could be started gradually when financial conditions permitted. The scheme practically remained more or less only on paper for some time. (141)

294: Measures for effecting improvement in Bombay : Mr. Bruen, the Animal Husbandry expert of Bombay, was, however, trying to get on. In 1933 he reported at the 1st Animal Husbandry Wing meeting that he had found it necessary that the efforts of Government farms must be augmented by outside agency. 4 or 5 *talukas* in the indigenous tract of breeds had been selected for intensive work. (141)

295. Intensive work for areas in Bombay : This intensive work in order to be fruitful required certain precautions, and these had been taken as under :

(1) Issuing of pedigree bulls to the areas ;

(2) Opening of Pedigree Herd Register and registering of all cows that came up to a specified

standard and were judged to be pure specimens of the breed from outward appearance. The registration was completed by tattooing the herd register number in the left ear, and in the right ear the abbreviated name (symbol) of the village. When the progeny were born, and if they were found to be true to type, they were also registered and tattooed.

8 different breeds were being registered at the time in many separate Pedigree Herd Registers.

Mr. Bruen observed that at that time the Government was in a position to purchase pedigree bulls, bred and reared in the villages, after the introduction of the system, at little or no cost to itself. (141)

296. Difficulties of the cattle breeder in Bombay : The general condition of Bombay was, however, not encouraging. In the Bombay Presidency the cattle breeder comes from a very poor class. The keeping of a bull entirely for stud-purpose is something very new. Bulls used to be dedicated to gods and temples and the breeder used these for his purpose. The dedicated bull is fast dying out except in a few places in the Dharwar District. The maintaining of a stud bull is an expensive business ; its feeding and care being almost a whole-time job for one man. When a stud bull is maintained, it is maintained for the benefit of a village as a whole and, therefore, the keeper must be remunerated in some way. (141)

297. Bombay premium bull scheme : To encourage the keeping of bulls in the Bombay Presidency, the Government offered the following premia :

(i) $\frac{1}{2}$ to $\frac{3}{4}$ purchase-price of the bull and no maintenance ;

(ii) A maintenance of Rs. 7/- per mensem if the agent paid full value of the bull ;

(iii) Service was free to the villager, outside-villagers being charged.

Funds were necessary to help the villager to purchase a bull and take advantage of the premium offered. The Sir Sasoon David Trust at the time gave Rs. 4,500/- at 2 per cent per annum. The whole of this amount was lent out in 2 months. It was provided that a third of the amount will be repaid each year. The recovered amount was to be invested again. (141)

298. Cattle Improvement Act : Bombay had passed an enactment for the castration of undesirable bulls by the Cattle Improvement Act. of 1933. This Act was supplemented by "The Bombay Live-stock Improvement Rules, 1935."

This Act and the subsequent Rules provided for the declaration of an area by the Government in which the Act and the rules were to operate.

This Act provided for the licensing of approved bulls in the area, and all persons were prohibited from keeping in possession unlicensed bulls under penalty.

The bulls could be inspected at any time and their condition noted. On the deterioration of the bull the licence could be cancelled. Unlicensed bulls could be taken possession of and sold and the sale proceeds given to the owner. This Act did not apply to bulls

dedicated to a religious purpose, and according to custom and usage. The limiting age of a male-calf which could be kept uncastrated was fixed at 2 years. After that a licence would be necessary. In granting the licence the Live-stock officer was to see that there was one bull for every 60 cows in the village.

In 1935, only two areas were brought under the operations of the Act. By 1942 there were 73 villages under the ambit of the Act, and some more villages were under survey. (141)

299. Reserved forest area for grazing : The improvement of breeding was at this time made synchronous with the extension of grazing areas, and about 2,300 square miles of reserved and protected forests were handed over to the Revenue Department for management, as being primarily more suitable for the production of grass than of timber.

Special rotations for the improvement of grass-crops were introduced in the East Khandesh District applying closure and rotation for grazing, making a 5-year cycle. The West Khandesh District was incorporated later on into this system leading to considerable improvement.

300. Bombay Cattle Associations : A Cattle Improvement and Dairy Farming Association was started as early as 1929 at the instance of the Governor of Bombay and by the efforts of Mr. Bruen. The scheme was a comprehensive one, and village associations were also formed and village committees were started to carry the improvement to the homes of the cultivators. Attractive methods of propaganda

were used for rousing common interest in cattle-breeding and its problems.

Touring cars were sent out with propagandists for the purpose. Village Associations were required to keep improved bulls and take proper care of their maintenance. The sympathy of the *goshalas* were enlisted. But the real difficulty came about the funds. Funds were certainly necessary to carry on all this good work. The Government, however, was unable to finance cattle improvement work in the villages. This venture could not subsist on mere propaganda, and because of the lack of Government help the movement died out.

301. Cow Keepers' Association : Later on a Cow Keepers' Association was formed and some dry cows were salvaged from Bombay. The milk yield of these cows was quite satisfactory and their progeny also showed quality. This endeavour also could not last for want of funds either from the public or from the Government. In spite of the difficulties and shortness of funds, Bombay was steadily pursuing its cattle improvement programme through village work.

In 1939 Mr. Bruen declared at the Animal Husbandry Wing meeting that in Bombay there were many groups of villages, consisting of as many as 90 villages in a single group, in which there will be seen only pure-bred stock, all numbered and registered.

302. The Kankrej tract : The village enquiry on the seven breeding tracts of India was undertaken to survey the tract for the Kankrej breed in Bombay. This area is situated near about Ahmedabad. In the

Bombay Presidency, Sanand Mahal is considered to be the home of the Kankrej cattle, though a fair number of the Gir are also bred in Dholka and Viramgaum, on the borders of Kathiawar. In this area buffaloes are largely kept by professional breeders and cultivators for dairy purpose. (56, 202, 258, 266, 287, 315, 337, 344, 366)

303. Poor care of Kankrej cows : The condition of the cattle is not different from many other tracts. The Kankrej area suffers from the poor care taken of the cows as compared with the she-buffaloes, and in this tract, it is reported, that the buffalo is steadily replacing the cow in the interior regions.

The cows are generally poorly fed. In the hot season they are left to subsist on what they can pick up in the over-populated grazing lands or cultivated lands after the harvest. When a cow has a male-calf she is rarely milked. When she has a female-calf she is milked, stall-fed and given some concentrates.

Buffaloes are, of course, better cared for. Concentrates, consisting of cotton-seed, gavar and barley bran, and oil cake are given. (56, 109-'27, 219, 236, 257, 278, 372-'76)

304. Rabari & Bharwad breeders of the Kankrej : The professional breeders in this tract are the Rabaris and Bharwads ; and this northern part of the Province of Bombay is fortunate in having them. They are a sturdy race of people with fine physique and intelligent look.

The professional breeders choose promising male calves at their birth, bred from parents possessing

strong constitution, size and milk capacity, also proper colour and form. They allow all the milk of the dam to the calf, and, at 2 or 3 months, allow it to suck another cow to provide it with plenty of whole milk. After weaning, the bull-calf gets a special feed consisting of *ghee* and turmeric powder along with the usual fodder and concentrates. Soon after weaning, the male-calves are sold to the cultivators after castration who rear them into bullocks.

These breeders are careful about their methods of breeding, and do not allow in-breeding. They change the stud bulls with other breeders when their progeny come to maturity. One striking fact about these breeders is their neglect of the female, in common with the generality of cattle-owners. They do not feed the female-calf or the heifer or the cow with the care that they should. Considering the care they bestow on the male, they certainly know the importance of nutrition and yet keep the cow, the mother of the bull, in a condition of neglect from the calf to the cow stage. These breeders generally exchange their heifers and cows amongst themselves and do not sell them. (199, 251)

305. Bull-rearing in Bombay : Regarding breeding of bulls for stud-purposes, Mr. Bruen felt that without sufficient subsidy it was not possible to rear a large number of bulls.

“...He (Mr. Bruen) had repeatedly tried to induce these people (commercial dairies in the Presidency) to rear good bulls, but they always wished to have a guarantee that Government

would purchase the mature bull at a specified price." He held that "unless the breeders were subsidised by the Government, there was no likelihood of getting good bulls. In the case of milch and draught, and draught-breeds, there was another difficulty. No two bulls over 3 years of age could live happily together so that the cultivators had to engage extra-labour to rear more than one bull. This they could not do without a subsidy...." (142)

306. Bull rearing : Subsidy necessary : "In Gujarat tract every village was producing the Kankrej cattle, but no breeder would keep the bulls and calves beyond six months of age, because of the difficulty of keeping two or more bulls together. These young bulls were, therefore, castrated at a young age and were lost as breeding bulls. If these young bulls were to be reared, they should either be taken on Government farms or a subsidy provided for rearing them. Rearing at a Government farm would be very costly....

"...The cultivators who had their own lands bought these young bulls and reared them up with a view to selling them as draught-cattle. "These animals," he thought, "must be stopped from going into the plough, and the only way of doing this was to subsidise. Bull-production in England was entirely different from that in India. In other parts of the world a dairy farmer who attempted to rear more than one or two bulls got about £ 300 to

£ 400 for a good bull, but in India a good bull could not be sold even at cost price." (*3rd meeting. A. H. Wing (1939.)—P. 92-93). (141-'42)*)

307. Breeding in the southern tracts of Bombay :

What the late Mr. Bruen observed about the rearing of bulls was too true. The Rabaris and Bharwad breeders of the Kankrej tract, specialists as they were in cattle-breeding, could certainly present the Presidency with a very large number of Kankrej stud-bulls and thereby grade up the entire cattle of the Presidency if the Government subsidised them to rear these bulls or guaranteed their purchase at a specified sum.

308. The North Kanara tract : The southernmost tract of the Bombay Presidency is the District of North Kanara. Here the climate is very unfavourable for cattle-breeding. 80 to 150 inches of rain fall in course of about 120 days. These three months of incessant rain are followed by nine months of drought. Yet the cattle have to be kept. One would suppose that cows would be preferred to buffaloes on account of the long months of hot summer during the greater part of the year. But no, here also the cultivator in his scramble for some immediate gain has been preferring she-buffaloes to cows. Here some bullocks are used for cultivation also.

There are 63.7 thousand cows against 24.5 thousand of she-buffaloes. The cattle are allowed bulky food, consisting of dry rice straw and grass in the summer, and in the rains and after, rice straw is supplemented by green grass from June to November.

Concentrates are allowed to the milch-cattle and to the working animals.

309. North Kanara cows starved ; she-buffaloes pampered : The cows are poor milkers and must be obviously so because the she-buffalo is the choice animal here. The cultivator allows the cows to be kept on starvation ration and goes to the extreme of pampering the she-buffalo. The proportion of bulls to females is very unsatisfactory. There is one bull to 130 cows, and 1 buffalo bull to 137 she-buffaloes. No wonder that many females lactate at long intervals. The she-buffaloes are generally well cared for.

“They are often fed on unbalanced rations, generally with excess of concentrated food by the cultivators in their zeal to tap the maximum quantity of milk. The fact that these animals give higher quantities of dung and urine and thus help the cultivators to prepare larger quantities of farm-yard manure, also goes a long way in intensifying the cultivators’ zeal to care more for the she-buffalo than other types of bovines. She is properly housed and is given good cold water baths every day in the hot summer to help her to withstand better the uncongenial climatic conditions. ... This lack of proper exercise, and feeding on unbalanced rations generally with excess of concentrated food materials create in the animals a tendency to develop fatty degeneration”. (Hegdekatte. *Agriculture & Live-stock in India*. May, 1932). (109-'27)

310. Buffalo vs. bullock in North Kanara : The peasants of North Kanara do neglect the cow and feed

the she-buffalo so much as occasionally to induce fatty degeneration, and then the cow is blamed for being a poor milker. Poor milker is the cry all over against the cow. And the more there is neglect of the cow, the poorer the milk, the weaker will be her progeny, male or female. The bullock is, therefore, growing weaker. The natural conclusion to this is what is happening in this district of North Kanara, where for every three bullocks one buffalo is used for draught. This proportion will increase in favour of the buffalo, the longer the differential treatment of the females of the two animals continue, till at last the cultivator may have to fall back more and more upon the buffalo only to find that it does not pay to plough the fields with these big consumers of fodder. This is the lesson that one may take from cattle-breeding in North Kanara.

In the Bombay Presidency there are certain tracts in Gujarat famous for agriculture. Here also the she-buffalo is favoured as a milch animal in preference to the cow. We shall examine what the she-buffalo in Gujarat brings to the cultivator which the cow could not have done. (109-'27)

311. Breeding in the Chharotar (Gujarat): The Chharotar tract in the Kaira District, Gujarat, is made up of Anand, Borsad and the southern part of the Nadiad *Taluka*. The cultivators are Kunbis who are far-famed for their skill in agriculture. In fact, under conditions where others fail, the Kunbi very generally succeeds in agriculture. The Chharotar tract is considered to be the garden of Western

India. And if Chharotar is the garden, it is the Kunbi cultivator that has made it into a garden. The tract is about 570 square miles or about one-third the area of the Kaira District. (109-'27)

312. The Kunbi cultivator of Kaira : The character of the soil in the Kunbi holdings has been improved by a long course of careful husbandry. Sandy portions near Nadiad, Borsad and Anand in the Kaira District in the Chharotar tract have been converted by these intelligent people into garden land. Similarly, the heavy and rather impervious cotton soils of the Surat tract have been made fertile by the hard work of the Kunbi.

"The Kunbi usually lives in a comparatively well-built house, two or three storeys high. The houses, constructed of bricks and tiles, are built in rows of three or four...

"His agricultural skill can be seen in the general high standard of cleanliness of his lands, his careful repeated ploughings, abundant manuring, perfectly straight sowing, utilization of every little space available for crop production, the skill with which rotation of crop is designed to build up and maintain soil fertility and the long distances over which irrigation water from wells is conveyed across all sorts of obstacles to his cultivated fields. The Kunbi is very fond of his cattle and he likes to tie them near or in his house so that he can feed them at night. Even the bullocks are carefully bathed in hot water in the evening after

a heavy day's work."—(P. 566-'68. *Agriculture & Live-stock in India. September, 1937*)

"The country around Nadiad is well-wooded, and no *Chharotar Kunbi* (the best cultivating caste)



Fig. 28. The Kunbi cultivator of Gujarat.
(*Agriculture & Live-stock in India.*, Vol. VII, Part V.)

burns dung, not even for cooking purposes. Manure is sold out of the town to the cultivators, they paying Re. 1/- for 20 maunds (of 40 lbs. each)"

—(P. 102. Voelcker, 1893).

313. Kunbis in the eyes of a Western observer :
The work of the Kunbi and his cultivated area is described by Voelcker in the following words :

"... Certain it is that I, at least, have never seen a more perfect picture of careful cultivation, combined with hard labour, perseverance, and fertility of resource, than I have seen at many of the halting places in my tour. Such are the gardens of Mahim, the fields of Nadiad (the centre of the 'garden' of Gujarat in Bombay) and many others."—(P. 11)

"..... It was at Nadiad too that I witnessed, perhaps, the most careful method of conservation of manure to be found anywhere in India."

—(P. 128)

And this was about 50 years ago. Such excellent cultivators and lovers of cattle were naturally attached to their cows and bullocks and must have as carefully reared their cows as they dressed up their land.

But even such shrewd cultivators have not been able to remain uninfluenced by the short-sighted craze of the present times for cheap, immediate gain by keeping buffaloes for milk. The times have changed, and so have the farmers, excellent as they were in their own line, realized that under the altered conditions "farming alone cannot maintain them, unless it is supplemented by some occupation like dairying which utilises advantageously the by-products obtained in farming and also secures greater employment to both male and female members of their family," says a survey report of the area by Messrs Ghatge and Patel.

314. Report on a few family surveys of Kaira :

"It has been observed that each farmer keeps one or more buffaloes on his farm, depending upon the availability of feeds and fodder and on the time which could be easily spared by both sexes to look after them. In 1936-'37 out of the thirty-one representative farmers under investigation two farmers could not maintain the buffaloes particularly due to the fact that there were no female members in their families who could look after the cattle."

Ghatge and Patel made elaborate enquiries into the dairying conditions in this tract and brought out cost and receipt accounts. From their figures certain items are culled to understand how milk-yield profitted the farmers.

29 farmers kept she-buffaloes, and to the share of each there were 1·5 she-buffalo on the average. The dairy accounts of each farmer may be put as under :

TABLE-17

For one family keeping 1·5 she-buffalo & their calves. (average of 31 families)

Expenses.	Rs. as. p.	Income.	Rs. as. p.
Cost for maintenance	100-1-3	By value of	
Miscellaneous charges	2-3-7	milk & ghee	132-0-8
Interest on the capital		By appreciation	
invested in live-stock		of stock.	3-1-7
feeds & fodder	14-13-1		
			<hr/>
			Rs. 135-2 3
	Rs. 117-1-11		
Profit by diff.	18-0-4		
	<hr/>		
	Rs. 135-2-3		

315. Profit of buffalo-rearing in Kaira: By keeping $1\frac{1}{2}$ she-buffaloes the *ryot* gets Rs. 1/8/- per month profit in exchange for the labour of the family ; and families having no proper working female members could not maintain the buffaloes. Buffalo-rearing can be regarded as good spare-time labour. For this labour throughout the year the family gets Rs. 18/- in cash or in the milk consumed in part, and also the manure obtained out of the buffaloes.

This calculation does not take into consideration the immediate and prospective loss to the family and the nation brought about by the neglect of cows which the introduction of a she-buffalo in the family means. I have little doubt that if the cultivators had not been led astray by bad examples, they would have got more by caring for the Kankrej cow for milking which would have certainly given them more valuable male issues than she-buffaloes do.

But who gave the bad lead ? The following passage from Voelcker's Report (1893) is suggestive of the efforts made during those days to popularise the buffalo. (109-'27, 287, 302)

316. One of the origins of the bad lead : "There is a farm of 12 acres, inaugurated in 1878 and kept up by the Agricultural Association. It is made use of in connection with the Agricultural Class attached to the High School. ..."

".... Male buffaloes are used in ploughing, a practice not locally adopted, but which it is sought to introduce"—(P. 368.)

The passage refers to the effort for the introduction of the male-buffalo for cultivation. That the females were encouraged to be fostered for milk goes without saying.

The endeavour to re-place bullocks by buffaloes did not succeed as there are only 1 male buffalo to 100 bullocks. But Kaira is a *ghee*-producing area and the number of cows to buffaloes shows how the cows have been pushed against the wall. In this district there were in 1935; 25, 978 cows against 128, 868 she-buffaloes, or nearly 5 times. And the contribution of these 1,28 thousand she-buffaloes to the male stock buffaloes is only about eleven hundred, whereas the 26 thousand cows supply one lakh sixteen thousand bullocks for ploughing the land. The actual figures are as under :—

TABLE—18

1934-'35.

Oxen			Buffaloes	
Bulls & Bullocks	116,783		Male buffaloes	1,166
Cows	... 25,978		She-buffaloes	128,868
Calves.	... 25,451		Calves.	136,747
—(109-'27)				

317. The cry for dual purpose cow : No wonder that from Gujarat was raised the cry and the warning for the development of the cow for milk, and for the "dual purpose" cow before the Royal Commission.

"... The double demand in Gujarat for good plough and good milking cattle has, naturally enough, suggested the desirability of combining draught and milking properties in one breed of animal,

and the importance of replacing buffaloes by good cows of a 'dual-purpose' type, was urged upon us . . ."

—(P. 217. *Royal Commission on Agriculture.*)

This cry and warning was throttled and neglected at the time. But it seems that a little change has been brought over Government breeding circles, specially after the Seven Tracts Enquiry and Report of 1937. (92, 109-'27)

318. Chharodi and other farms of Bombay : The Chharodi cattle farm of the Bombay Government was handed over to the Agricultural Institute in 1940. There were two cattle-breeding farms at Bankapur and Tegur. At the Bankapur Government Farm the Amrit Mahal breed were being worked up for early maturity. A small herd of Gir cows and bulls was added to the farm to propagate the Gir breed. At Tegur an effort was being made to evolve a suitable type for Konkan. At this centre the Dangi and Nimari breeds were being attended to with the object of evolving a suitable "dual-purpose" animal for the coastal tract.

The valuable Gir breed, the "dual-purpose" animal with wonderful quality of prepotency, was very nearly extinct. It was not available in its home tract in Kathiawar.

The Go-Rakshak Mandali and the Nathulalji Charity Trust Fund Gowshala are maintaining and developing the Gir breed, a very laudable piece of work in addition to their other activities. (48, 49, 231)

319. Breeding in Sind : Sind has recently been created a separate Province carved out of Bombay.

Prior to this division, the Bombay Government policy controlled the cattle breeding of Sind also.

Sind is particularly favoured in being the home of some of the best breeds in India. The Tharparkar breed comes from the district of Tharparkar, and there are the Red Sindhi and the Bhagnari breeds all prized for their utility.

320. Three breeding tracts in Sind : The breeding areas in Sind can be divided into three tracts as follows :

- (1) Tract to the left bank of the Indus ;
- (2) Tract to the right bank of the Indus ;
- (3) Tract comprising the deltaic area of the lower Sind.

(1) The left-bank area is large and has perennial irrigation. The Tharparkar district is in this tract, and is well-suited for cattle-breeding. In this tract the Government is purchasing Tharparkar bulls and rearing them at a central farm for one or two years. They are sent to the Cattle Improvement Committees on reaching maturity for distribution to the selected *ryots*. Bulls under this system have been distributed in Tharparkar itself and also in the Nawabshah and Hyderabad districts. They are reported to have done very well, their progeny being superior to the local cattle.

(2) The tract to the right bank of the Indus is subject to the extremes of hot climate and is suited for being the home of the Bhagnari breed. Here young Bhagnari bulls are reared up to their attainment of medium size, and then distributed

amongst the *ryots*. The Bhagnari is prized as a draught-breed.

(3) The Red Sindhi is the cow of the tract in lower Sind. It is a heavy-milking animal and is most suited for the milk supplies of towns, like the Sahiwals. The Red Sindhis are even now bred by professional breeders of nomadic tribes. The nomads shift from place to place to graze. During the rains the cattle are taken to the hills of Thanobullah Khan. When the hill grazings are finished they are moved along the river bank through forests.

The Sind Government has stationed some Tharparkars at the seed-farms of Mirpurkhas. A herd of Red Sindhi has been established at the Willingdon Cattle Farm at Malir near Karachi.

The Province has forests and pastures along the river course. In the irrigated area there was danger of over-emphasis being put on money-crops. But the Sind Government is alive to this, and proposes to enforce reservation of a certain fraction of irrigated lands for the growing of fodder. In Sind they grow *babul* plantation in the fields. They irrigate the land and drill in *janar* or *bajri*, and plant *babul* trees in the field 30 or 40 feet apart. The *babul* trees are cut in the winter, the leaves are dried, and mixed with rice bran are given to milch-cattle or dry cows as concentrated food along with rice-straw as roughage. The *babul* was, therefore, the most important tree in Sind.

The Tharparkar is a dual purpose breed just like the *Hariana*. The performance of the *Hariana*

and the Tharparkar are almost identical in many respects. (252)

321. The Tharparkar and Hariana compared : Examination was made of the Hariana and Tharparkar herds at the Imperial Cattle Breeding Farm (Karnal). (Dave. *Agriculture & Live-stock in India. January, 1933*). It was found that ;

(1) The average period after calving after which the cow of the Hariana and the Tharparkar breeds take service worked out to be 75 days in the case of Hariana and 73 days in the case of Tharparkar.

(2) In the majority of cases (70 per cent) both the breeds hold service within three months.

(3) The Hariana calves once in 358 days and the Tharparkar in 356 days.

(4) The Hariana took service mostly in the four months from March to June ; whereas the Tharparkar took service almost uniformly throughout the year.

These facts were true about the particular herds at the time, and may not be true for all the Harianas and Tharparkars. These figures show that under identical climate and management, and in the same farm, both the Hariana and the Tharparkar behave similarly about periodicity of calving. There is one difference in the matter of the season for service. It may be explained in this way. The Hariana is in its native land at Karnal, and the climate and seasons have remained uniform with the herd for generations. In its own surroundings, March to June is the best service season and December to March

the calving season. When the cattle are kept in ranches in their natural condition, they get served and calved at such seasons as are most suitable for rearing up the young one. But when a herd is taken away from its natural surroundings and stall-fed in another climate, the time of service and calving almost cease to be dependent on the season, and, therefore, the average time of calving works out almost uniformly at all seasons of the year, as in the case of the Tharparkars transferred to the Punjab from Sind. (59, 73, 254, 266)

322. Tharparkar and Hariana—lactation yields and period : The average lactation yields of the two herds of Tharparkar and Hariana were as under in 1937-'38. (Kantha. I. C. A. R. 8.36. P. 22 & 30)

TABLE—19

	Lactation Yields in lbs.	Days.
Tharparkar	4,719	284
Hariana	4,417	268

The average of yield per lactation for the Tharparkar is 4,719 while that for the Hariana is 4,417; and the number of days of lactation for the Tharparkar is 284 and that for the Hariana is 268. The Hariana has less number of days, and, therefore, less total lactation yield. But it is a short average that has been worked out. It can, however, be said on the basis of the figures that the lactating performance of both the breeds are nearly similar. That both the breeds are good draught-breeds is well-known. (73)

323. Haryana-Tharparkar—fat percentage : The detailed records of fat-percentages are not generally available. But in the case of the Karnal herds of the Tharparkar and the Haryana these were made available. Mr. Kothawalla, Imperial Dairy expert at the time, arranged in 1932 for the testing of samples of each milking of all cows in the herds under his control. The study is based upon the fat-tests recorded in respect of the Haryana and the Tharparkar cows at the Imperial Agricultural Institute, Karnal.

The study was of fat-tests of 51 Tharparkar and 45 Haryana cows. The averages worked out thus :

Tharparkar	...	4.55 per cent of fat.
Haryana	..	4.59 "

—(Kothawalla & Kartha. *Agriculture & Live-stock in India. May, 1939*)

The range of fat i. e. the lowest and the highest fat-content being the same for both, namely 3.8 per cent lowest and 5.2 per cent highest. Fat percentages of both increased with the advance in lactation. The rate of increase per cent per month being,

Tharparkar	...	.062
Haryana	...	.079

The above comparative study will indicate the importance of the Tharparkar breed. (73)

324. The Red Sindhi : The Red Sindhi cows are proving themselves suited to any climate in India as their successful breeding in the following Government farms will show :

TABLE—20

Milk yield of Red Sindhi

Name of Government Farms.	Maximum yield in one lactation in lbs.	Lactation Days
Agricultural College Dairy, Coimbatore.	5,721	589
Live-stock Research Station, Hosur.	6,687	395
Govt. Agri. College Dairy Farm, Cawnpore.	3,147	259
Imperial Dairy Institute, Bangalore.	6,589	352
Allahabad Agricultural Institute, Naini.	3,979	284
Govt. Military Dairy Farm, Peshawar.	... 9,283	351
Lucknow.	... 5,242	325

—(Kantha. I. C. A. R. 8.36.)

It appears from the above that the Red Sindhi has been thriving and doing equally well in diverse climates and far away from its home tract, at Coimbatore, at Bangalore in southern India, and from Peshawar to Lucknow in northern India.

Mr. Smith, late Imperial Dairy expert, wrote about this breed as follows :

“It is one of the purest and most distinct of Indian breeds of cattle ; it is, moreover, the only breed of commercially profitable dairy cattle in this country outside of buffaloes, which can be purchased in large numbers.”

Things have changed since 1935, and the Sahiwal has risen to occupy a very high place in Indian dairying. Which of the two is "better, considering all aspects, it is difficult at this moment to say. But, it is a fact that the Sindhi is and will remain the best milker of southern India whereas the Sahiwal will be regarded as the best milker of northern India without drawing the two to a comparison.

Mr. Littlewood published some interesting details about the Red Sindhi. (*Agriculture & Live-stock in India. May, 1935*)

"For the past 12 years a herd of Sindhi cows has been maintained by the Madras Government. Formerly, these animals were kept at the Agricultural College Dairy, Coimbatore. On the acquisition of the Hosur Cattle Farm in 1924, most of the cows and young stock were transferred to Hosur and further purchases of Sindhi cows were made through the Imperial Dairy expert....There is great demand for bulls of this breed and the present supply is not sufficient to meet it; they are required to grade up the poor stock on the West Coast in Malabar and South Kanara districts, for stud purposes in urban districts....Bullocks of this breed are used for work purposes on some of the agricultural stations including two of the paddy-breeding stations, and are proving satisfactory workers." (73)

325. Red Sindhi thrives at Hosur : "It is found that this breed maintains good condition at Hosur and is a thrifty feeder. The stock born and reared on the Farm are a little larger in size than the

foundation-stock. Lately, several well-developed young bulls of 22 to 24 months of age have been tested for service and found satisfactory, but they are not issued for breeding-purposes until they attain $2\frac{1}{2}$ years of age." (73)

326. Red Sindhi best for small dairymen: "The Sindhi cow is one of the best for the small dairyman, it is not a large animal and it eats less food than the larger cows such as Ongoles, Sahiwals etc., and is a thrifty feeder and maintains good condition on fairly scanty rations...."

"Bulls for breeding-purposes from Hosur have been sold to the Imperial Institute of Animal Husbandry and Dairying, Bangalore, and to Bengal, Cochin and Ceylon Governments.

"At present time a herd of 70 Sindhi cows is maintained at Hosur and records maintained for each animal. The following particulars have been worked out up-to-date. (73)

327. Milk yield of Red Sindhi : "The purchased foundation-stock have averaged 3,572 lb. milk with a daily average of 11·9 lb. The farm-bred cows, including first calvers, have averaged 4,137 lb. with a daily average of 11·9 lb.

"Eight cows have yielded over 6,000 lb. and 11 between 5,000 and 6,000 lb. of milk in a single lactation. The average maximum yields of these are—

Foundation-Stock	...	4,416 lb.
Daily average	...	12·06 lb.
Farm-bred cows	...	4,467 lb.
Daily average	...	12·8 lb.

"Taking the whole herd, the cows have averaged 3,251 lb. milk in 309 days with a daily average of 10·5 lb. They have calved on the average every 16 months."

WEIGHTS

"The average weights of calves at birth are—

Bulls...47 lb.

Heifers...42 lb.

The average weights of adult stock are—

Bull...950 to 1,000 lb.

Cow...650 to 750 lb."

—(73)

328. The breeds favoured: The North West Frontier Districts were made into a Province recently. For animal husbandry work the Province has been divided into two areas, the Hills and the Plains. In the Hills the prized breed is the Sindhi breed while in the Plains contiguous to the Punjab the breed of choice is the Dhanni. The Lohani breed of Baluchistan is also receiving encouragement, and attempts to breed these in numbers have been going on.

329. Attempts at improvement—a good beginning: In this Province the Kurram Valley on the border of Afghanistan responded to the call for funds for the Viceroy's gift bull scheme. Rs. 5,000/- was collected here compared with Rs. 15,000/- collected in the whole Province. The Kurram Valley is not bigger than a *tehsil*, and in this small area 50 bulls were distributed for intensive work. Another 600 bulls were distributed in the 6 districts of the Province, including

the Agency areas of Chitral, Dir, Siwat on the border of Russia. About 450 bulls had been distributed by 1939. Live-stock Improvement Boards had been started with enthusiastic members. In 1939 the Government subscribed Rs. 15,000/- and the District Boards another Rs. 15,000/- for the maintenance of bulls, and this was a recurring annual grant. In this way a very good beginning was made.

330. Improvements in the N. W. F. P : The current movement has changed the aspect of animal husbandry in the Province. It used to import five to six lakh rupees worth of plough-cattle from the Punjab ; but now all that is going to be changed on account of the introduction of the subsidy scheme. The scheme is operating so successfully that the import of cattle from the Punjab has considerably diminished ; several cattle *mandis* or markets on the borders of the Punjab have been abandoned. The villagers of this border area have a separate fund for the maintenance of the bulls. From this fund a subsidy of Rs. 8/- per month for each bull is distributed.

Bulls were allotted to those areas only where there were facilities for cattle-breeding. When the villagers apply for a bull, an enquiry is made about the suitability of the area ; and when a bull is allotted, a sum of Rs. 50/- per bull is realised from the allottee to be paid in instalments of Rs. 8/- per month.

The 450 bulls distributed were taken good care of. The veterinary assistant of the *ilaga* sees the condition of the bull once a month, while the superintendent

visits the bulls now and then. A record is kept of the service of the bulls, and of practically every cow born.

Funds, however, were necessary in a large measure to carry the improvement to the villages. The Government accepted the suggestion of the Provincial Association and agreed that to raise funds a small amount be levied on the sale of all cattle in fairs as cess. It was also suggested that the export of hides, skins, hair, wool etc. be subjected to a small cess, which would go towards meeting the current expenses.

331. Village shows and propaganda : Village shows and propaganda work were carried on with zeal. Funds for the purpose were annually granted both by the District Boards and by the Government. In 1939 the two bodies contributed Rs. 3,000/- and Rs. 3,500/- respectively for the purpose. Shows were held in villages and the progeny of the cattle were exhibited. For propaganda on the improvement of the breed and for proper nutrition etc. a very large number of instructive pamphlets have been issued. A list of the propaganda leaflets would be interesting. This leafleting is not, however, a special item for the N. W. F. P. Leaflets are encouraged to be created and distributed in all the Provinces. But the leafleting in the N. W. F. P. seems to be thorough and ambitious.

There are listed 34 pamphlets on breeding, 28 pamphlets on milk, and 20 pamphlets on miscellaneous aspects of animal husbandry.

The list is a formidable one and the N. W. F. P. cultivators, if they can take advantage of this free

literature, must be gaining considerable knowledge of animal husbandry, its principles and methods. But, it is a matter of doubt if these pamphlets really reach those for whom they are intended, or are read by them. If even a fraction of them read these and translate the knowledge so obtained to action much good might follow. The N. W. F. P. Government thinks that their propaganda has been effective in as much as the Dhanni breed is being reared largely in the Province because of the efforts of the Government.

332. Breeding in the Central Provinces : Position in 1927 : The position of cattle breeding in 1927 was recorded by the Royal Commission as under :

“Although there are nine cattle-breeding farms in the Central Provinces, two of which have been in existence for some twenty years, the actual output of pedigree bulls is still very small, and it is only now that schemes are being discussed for multiplying the effect of the stock-animals raised at central farms by concentration of effort in selected areas. Conditions in this Province make the work of cattle improvement peculiarly difficult. There appears to be only one local breed, the Gaolao, possessing any distinctiveness of type. The cultivators of the cotton tract, who treat their draught-cattle well, are not breeders ; local conditions are unfavourable and they rely largely on bullocks imported from the grass-tracts to the north. Cultivators in the wheat-growing tracts keep such poor cattle that extensive areas may be seen infested with *kans* grass and left untilled because the bullocks are too

weak to pull the implements required to clean the land; whilst the cattle of the rice-growing tracts are even worse than those in which wheat is the main crop. Cattle of fair quality are to be found only in the tract in the north-west of the Province which borders on the extensive cattle-breeding tracts of Central India, and these owe their origin to tribes of professional herdsmen keeping Malvi or similar cattle. An attempt has been made to give the nondescript animals, to be found in most areas, some definite character by grading up. The Montgomery bull has been used as a sire and the policy has been to transmit the milking qualities of this breed into the local cattle. The type of animal raised is appreciated by milk-sellers, but the Montgomery type is not favoured by cultivators. ...”—(P. 219)

333. Milk supply of Nagpur city: “Much attention has been paid to the milk supply of Nagpur city and the surrounding district. A herd of pure Sahiwal (Montgomery) cattle is being raised at the Telinkheri farm in Nagpur and the local milk-sellers (*gowalas*) have been formed into a successful co-operative society to improve both the feeding and breeding of their buffaloes and cows. At the dairy farm attached to the Agricultural College and at Adhartal, the more ambitious object of creating new breeds is being attacked.”

—(P. P. 219-'20).

“It is possibly because the cattle of Berar are relatively good as compared with those of the

wheat and rice-growing tracts, that attention hitherto has been concentrated on improving breeds for the latter tracts; but the policy was one of doubtful wisdom, for until greater attention is given to feeding, the distribution of a few "premium" bulls in the wheat and rice-growing areas of the Province cannot be of value. It appear to us that, in the Central Provinces, the breeding of types of draught-cattle likely to be appreciated in Berar, should be taken in hand, and that associated with any cattle farm provided for raising pedigree bulls, there should be a controlled area in which the improved strains of stock can be multiplied for distribution.

"The obstacles to improvement in this Province are much more formidable than in the Punjab, the United Provinces and Bombay, and it is, therefore, gratifying to find that much attention is now being given to the subject."—(P. 220). (1205)

334. The position of cattle-breeding: The position of cattle-breeding by 1939 was that there were 561 pure-bred bulls in service of which 331 were presented in response to the "Gift Bull" scheme, and 163 were purchased from funds allotted by the Central Government. The Hariana was being introduced into Berar and the Malvi into the northern districts while the Sahiwals were being given to the urban areas. The Co-operative Society of the *Gowalas* was still functioning in Nagpur and it was successful with Sahiwal crosses. But the C. P. breed of Gaolao was not till then tapped for experiment.

The question of fodder was as difficult in this Province as in many others. The cattle could be maintained on available fodder from cereals for six months only. For the rest of the year the cattle had to depend on forest grazing,

The Province is a large one. The total area is 63 million acres of which 28 millions are cultivated and current fallow, 19 millions are cultivable waste and uncultivable, and 16 million acres are forest. The cultivated land maintains a population of 15 millions.

335. Cattle population of C. P : The cattle wealth of the Province is as under. (1937) :

TABLE - 21

	In thousands	
Bulls	..	109
Bullocks	..	4,028
Cows	..	3,178
Calves	..	3,280
He buffalo	..	514
She buffalo	..	801
Young stock	..	704

336. The four tracts of C. P : From the point of view of cattle-breeding the Province can be divided into tracts for crops which determine the sort of animals that are generally to be found in these.

- (1) Saugor and Jubbulpore—the wheat tract.
- (2) Bhandara—the rice tract.
- (3) Amraoti—the cotton tract.
- (4) Nagpur-Wardha tract—of mixed farming.

The rice tract is least suitable for cattle-breeding, because the fodder resources are poor. Saugor and

certain parts of Wardha and Balaghat are suitable for encouragement of cattle-breeding on account of the possibility of their fodder-resources. (202, 258, 266, 287, 344)

337. The breeds of cattle : The Gaolao cattle are bred mostly in the Wardha, Nagpur and Chindwara districts. The Khamgaon cattle are reared in the Buldana District and in the north-west of Akola. In Berar there are two distinct breeds—the Khamgaon of the western Berar and Umardha on the eastern portion of Berar. The Nimari and Khamgaon breeds are met with in Nimar ; and the Malvi is the local breed of Saugor and Mandla.

The cattle are poor generally except those of the well-known breeds of Gaolao, Nimari, Malvi, Khamgaon etc. The cows are very poor milkers, and the she-buffaloes, although they have imposing horns and large bodies, are as poor milkers comparatively, as the cows are. The bullocks are excellent, rapid and strong animals. In this vast area of 28 million acres, it is to be regretted that the milking quality of the cows has been neglected so long ; it is just receiving attention and improvements are being sought for. (302)

338. The C. P.—a poor Province : The C. P. is a poor Province ; it has a large amount of poor soil, the cattle are poor, and the people in the interior of some of the districts are extremely poor. The average lactation-yield of cows in the areas, surveyed in 1937, was only 411 lbs. and that of the buffaloes 1,513 lbs. The over-all per capita consumption of milk equivalents in the surveyed tracts was 6·73 ounces only.

The cows, poor milkers as they are, remain dry for 11·8 months and this brings the over-all dairy milk yield to '66 lbs. only ; the daily milk-yield, including lactating and dry period, being the poorest yield of all the seven tracts enquired into. The over-all yields of cows of the seven tracts were found to be as under.

Montgomery—2·53 ; Ongole—2·17 ; Hariana—2·16 ; Kosi—1·74 ; Kankrej—1·68 ; Bihar—1·27 and C. P.—·66 lbs.

In the over-all yield for buffaloes, Bihar, however, shows equally poor yield with the Central Provinces. The over-all lactation of the seven tracts being as follows for buffaloes.

Montgomery—4·43 ; Ongole—3·5 ; Hariana—5·83 ; Kosi—3·57 ; Kankrej—3·29 ; Bihar—2·33 ; and Central Provinces—2·34 lbs. (47)

339. Uplift of cow necessary for uplift of the Province : For the economic uplift of the C. P., the uplift of the cow is essential as it is essential for the whole of India. With very little irrigation and poor soil in large tracts of the Province, it is indeed, a very up-hill work. The milk-yields being very low, it may be possible to raise this up and show results quickly with a certain amount of comprehensive effort.

In the surveyed tracts the price for a bullock was Rs. 40/-, whereas that for a plough-buffalo was Rs. 20/- only, showing the disparity in working efficiency of the male-buffalo for the soil of the C. P., although a good number is employed for this work. The estimated price of a cow for slaughter was Rs. 7/- and of a buffalo Rs. 10/-. The prices of hides were

comparatively low, because for the poor quality of hides and for the goad marks on them. This Province annually imports from the adjoining Native States of Hyderabad, Indore, Gwalior etc. a large number of working bullocks.

340. Cattle-breeding needs in Central Provinces :

The specialized needs of the cattle of the various tracts in this Province are as follows :

Rural Berar and western circle :

(1) Active quick-moving bullocks capable of dealing with a large acreage of light cultivation.

(2) Greater size and weight to provide for the general tendency to deeper primary cultivation.

(3) Better milking cows to provide more milk for human consumption and for calves, making her worth better care.

Rural North :

(1) Capacity for heavy and deeper cultivation ; strength and ability to pull is more essential than speed.

(2) Milk if procurable.

Rural southern circle, Nagpur Division, and parts of the Plateau :

(1) Quick-moving with some increase in body weight.

(2) Milk if procurable.

Chhattisgarh :

(1) A small, hardy, well-muscled male suited to the condition of the particular climate and food supplies.

Urban and semi-urban area in any of the above parts of the Province :

(1) Higher milking cows.

(2) Working males, types not so important, but tending if possible to meet the particular needs in its own tracts, as providing a better selling animal.

Taking into consideration all these requirements in the various parts of the Province, the following breeds of cattle are recommended :

For Berar, a medium type of Haryana cattle is being tried, as this breed is well-known for its purity of blood and possesses both qualities, namely, high milk-yield in cows and quick movement in bullocks.

The Khamgaon breed if developed as a "dual-purpose" animal will go a long way towards meeting the needs of this tract.

For rural North, the Malvi breed, now of some years' standing at Powerkheda Farm, suits the main need of this tract, that is, powerful but slower draught ability. This animal could be bred to produce milk for local requirements.

The Montgomery bullock by itself will not be effective except in the urban areas. A cross breed between the Malvi and the Montgomery is supposed by the Government department to be able to provide the breeder with an ideal stock for the area, i. e., dual purpose, combination of efficient heavy draught and milk

For the southern circle and the Nagpur Division and parts of the Plateau :

The well-known indigenous breed, the Gaolao, provides the milk and the working requirements of the tract.

In Chhattisgarh the problem is difficult. There is no use attempting to build a big breed by grading Chhattisgarhi cows with either a Malvi or a Montgomery bull. The climate and food supplies are all against the survival of such a breed. The only resources to work with Chhattisgarhi materials, with a definite programme of breeding, by selection.

For urban areas throughout the Province, Montgomery blood is being tried by the local department. It may be a mistake to do so in rural Central Provinces and Berar, but it is not so when the milk becomes



Fig. 29. The Vanzari Breeder.

the chief source of profit and the local breed does not immediately show prospects of high milk-yielding. A Montgomery herd is being developed at the Telinkheri Dairy Farm in Nagpur which has succeeded in developing a medium type of heavy milking animals suited both for milk and draught. (64)

341. Breeding in Bihar : deterioration travels west to east : The deterioration of stock becomes perceptible as one travels down the Jumna from the extreme west, say Muttra, to the extreme east of the U. P. The deterioration in the U. P. reaches its maximum where the Ganges enters Bihar.

The course of progressive deterioration towards the eastern areas becomes perceptible till the boundary of Bihar becomes common with that of Bengal.

In the enquiry of the seven breeding tracts of India (I. C. A. R. 8.22) the tract chosen in Bihar was the two banks of the Ganges at its entrance into the Province up to Dinapur near Patna city. It was a contiguous tract of land in the Gangetic plain comprising the Hajipur Sub-division of the Muzzaffarpur District, the Dinapur Sub-division of Patna and the Sadar Sub-divisions of the Saran and Shahabad districts. The enquiry was conducted in 60 villages at random in 1936-37. From this account the condition of the cattle in other parts of the Province may also be judged. Buffaloes are kept for milk and cows for the supply of draught-bullock. This is the general rule, although the milk-yield of poorly-nourished buffaloes sometimes equals that of the poor cow. From the report quoted below, we can get an idea of the present order of things in cattle husbandry in Bihar.

342. The condition of the cattle : "The indigenous cattle of Bihar are somewhat akin to the deteriorated Haryana type of animals. The deterioration has, perhaps, reached its highest

degree. The local cows are about three to four feet high and are in the most shocking condition...The bad health is manifested by the fact that the cows become unfit for breeding, only after three to six lactations. Such a bad state of health is due to the absence of proper grazing ground and the insufficiency of fodder. The animals are practically kept tethered all the time when the land is sown."—(P. 82)

343. The Seven Tracts Report on Bihar : "The indigenous *Brahmani* bulls released by the public are mostly responsible for breeding. They mostly belong to the same deteriorated type to which the cows belong. Of course, there are some people who are interested in cattle-breeding and have released good bulls by purchasing bull-calves of better breed, i.e., Haryana and Hissar. These bulls have improved the cattle of the Shahabad Diara. The Koirs and Ahir cultivators of Madhubani Sub-divisions of Darbhanga District also release good bulls which produce tight-skinned, short-legged, short-tailed and active bullocks of medium size. The cattle of Madhubani Sub-division in Darbhanga District and Sitamerhi Sub-division of Muzaffarpur District are very famous for producing good bullocks. In the Madhubani Sub-division of the Darbhanga District, especially in the Bachhaur Pargana of the Sub-division, the cows having bull calves at heel are not milked at all unless the milk is required for invalids or medicines and the calf is allowed to suck the whole of it."—(*Ibid*)

344. Calf rearing : Bihar calves like their mothers have very bad health. The calves generally get half of the milk during the first month, and one-fourth during the second and the first half of the third month ; after the two-and-a-half months the calves seldom get more than 8 ounces daily.

“The condition of the calves is very much deplorable in the villages, where the disposal of milk is easy and convenient. The calves do not get any concentrate feed regularly. The bull calves which are well-built and expected to be good bullocks get more milk from the very beginning They are very much cared for.”—(P. 83)

(202, 258, 266, 287, 302, 336)

345. Bad health of the mothers : “In the Bachhaur Pargana.....almost all the Koir and Ahir cultivators keep cows for rearing bullocks. The cows having bull-calves at heel are not milked at all, whereas those having female calves are completely milked which results in the bad health of mothers and further deterioration in the stock.”—(*Ibid*)

346. Milk—cows & buffaloes : “An average cow does not yield more than 500—800 pounds in a lactation which normally lasts for 6 to 7 months. Most of the animals fall below 500 lbs. in their lactation yields, and only a few are found to be yielding over 800 lbs.

“As the buffalo milk is richer in fat-content than cow's milk, the former is converted into *ghee* and the latter is used as milk. The percentage of fat in milk in the case of buffaloes comes to 6 to 7 and

in that of cows 3 to 4. In some cases, where the buffaloes are in a very bad health, they are no better than cows so far as their *ghee*-producing ability is considered.—(*Ibid*). (109-'27)

347. Breeding in Bengal, Orissa & Assam : The Province of Bengal borders on Bihar lying to its west. It has already been observed that the cattle deteriorate as the region extends towards the east from the U. P. In fact, the whole of northern India may be taken as an unit, being a valley of the Indus, the Jumna, the Ganges and the Brahmaputra. The cattle are at their best in about the extreme western region, and then as we pass the eastern boundary of the Punjab, deterioration becomes markedly visible. With the eastern boundary of Bihar, the breed-type seems to disappear ; these are absent all over Bengal, Orissa and Assam. The Siri or the Hill type is an exception, found on the hills of the Himalayas near Darjeeling. All over the plains the cattle are a non-descript mixture of Hill type.

In Maldah, the western boundary District of Bengal, the cows are more or less like the Bihar cows. But as one follows the course of the Ganges the cows get more and more deteriorated. (378)

348. Better milk types imported into Bengal : It has been observed that throughout India cattle thrive better naturally in the dry tracts—and the quality of the cattle of the deltaic tracts, where the land is often under water, gets deteriorated. Whatever be the reasons for deterioration, those reasons have undoubtedly been operating in Bengal. Side by side, it

is a fact that even in Bengal, with such a heavy rainfall, high milking-types like the Montgomery and draught-types like the Haryana thrive without suffering any appreciable deterioration, if they are well cared for, properly stall-fed, and grazed on hard ground. These conditions are possible in the towns only, where the Punjab breeds, mentioned above, do thrive. Therefore, there is nothing in the climate



Fig. 30. Soberano—32 months old bull.
Breed—Nellore (Ongole); (*See Para 222*).
Won the 1st. prize in its class. Bred and owned
by Pedro Marques Nunes, Fazenda Indiana.
(*Indian Farming.*, Vol. II, No. 8)

and in the rainfall of Bengal that stand against the development of better draught-types and milk-types.

349. The difficulties of water-immersed Bengal :
The greatest part of the land remains under water for three to five months in East Bengal, and the cattle are allowed hardly sufficient standing space. Fodder is most difficult to obtain in that season. In fact,

starvation conditions prevail. The rains make the soil soft and yielding, and the heavy animals find it difficult to move. The rice fields have to be worked in poodles. Here heavy animals are less useful as their feet sink deep down and movement is made difficult. Light-weight animals can only do ploughing work in the rice fields. Bengal is one big rice field. (504)

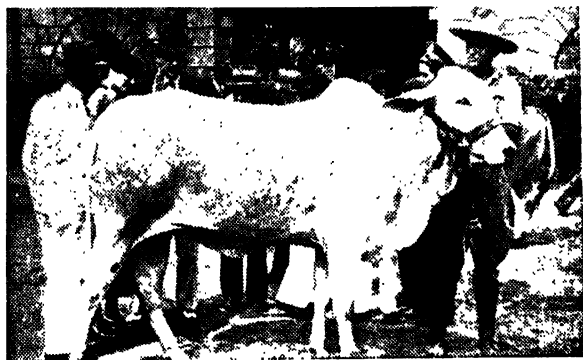


Fig. 31. Alegria—2½ years old calf.
Breed—Nellore (Ongole) ; (*See Para 222*). Won
the 1st. prize in its class. Bred and owned by
Pedro Marques Nunes, Fazenda Indiana.
(*Indian Farming.*, Vol. II, No. 8)

350. Government scheme of bull distribution :
The Government has been trying to grade up the non-descript cattle of Bengal by distribution of Harijana bulls. The scheme was to distribute a hundred bulls in each one of the districts of Bengal. There were 2,503 approved bulls in the Province in 1942 ; two lakhs of scrub bulls were castrated and one-and-half

lakhs of the progeny of stud bulls tattooed. And 56 maunds of Napier grass cuttings and fodder seeds were distributed free to encourage fodder cultivation. The scheme has been working in 22 districts. It is difficult to make any impression on Bengal by the distribution of these bulls. Besides, the time has not yet come to form an opinion of the result of crossing the non-descripts of Bengal with the Haryana.

The fodder problem is a difficult one in Bengal. In many parts of Eastern Bengal for several months in the year, during the rains, the cattle have to be confined to their tether and fed on whatever comes handy; for everything is submerged. The water hyacinth, which is really a pest, covers large tracts of water and destroys paddy fields. The leaves of these are fed to the cows. They cause diarrhoea; but still the cattle get something to chew during these trying months. Will the graded-up animal be able to survive this ordeal and still remain an efficient milker or draught-animal?

The problem of improvement of cattle has not been really touched despite the eagerness of the Government Department concerned. (141-'42, 509, 511)

351. Orissa & Assam in the same plight as Bengal: The position is more or less the same in Orissa and Assam. Whatever measures will lift up the cattle of Bengal will also be practically applicable to Orissa and Assam. The existing state is as pitiable in Orissa and Assam as in Bengal.

The introduction of pure-bred Harianas or Montgomerys for the milk supply of towns does not affect

rural Bengal. More milk and more draught capacity have to be put into the existing non-descripts while the fodder problem has to be tackled on a vast scale. A beginning to secure these ends has not yet been really made.

352. Cattle-breeding operations in Indian States : Not much is recorded about the cattle development work in the Indian States. The western Indian States of Kathiawar constitute the home of the Gir breed. In the States of Junagarh, Bhawnagar and Morvi, efforts are being made to maintain the breed pure. The Bhawnager State maintains a good herd and helps the local breeders by compulsory castration and distribution of bulls. The cattle of this tract have suffered a great loss due to export for city milk supply and to foreign countries. The local breeders, the Rabaris and Bharawads, are inclined towards buffaloes, or sheep and goat breeding. Most of the States have now stopped the export of cows from their tracts.

In some of the States of Rajputana and Central India like Jaipur, Jodhpur, Bikaner, Indore and Gwalior, steps are being taken to improve the local breeds like the Nagore, Rath, Malvi, Nimari. But the working is not any way effective.

In the southern Marhatta country the Nizam Government is trying to develop the Deoni cattle, and have a farm at Hingoli. The Malvi and Krishna Valley cows are also being developed for milk production. (49, 51, 54)

CHAPTER VII

ECONOMIC CONTRIBUTION FROM THE CATTLE IN INDIA

353. Wealth produced by Indian cattle : The cattle in India supply bullock labour for cultivation and road transport ; the cows give milk and provide nutrition to the nation. They convert grass and fodder into manure which has a definite assessable value. Those that are slaughtered supply food in the form of meat. And every animal after its death yields the hide, and thus again contributes to manuring from their carcass and bones. All these are assessable items. Assessment is difficult, but within wide margins some figures have been arrived at.

354. Olver's and Wright's assessments : In 1933 Sir Arthur Olver assessed the values of the above heads and found that the sum-total rose up to Rs. 1,900 crores. Later on, in 1937, a re-assessment was made by Dr. Wright for his Report with the help of experts. Mr. Vaidyanathan who jointly with Sir Arthur Olver had estimated in 1933, also helped Dr. Wright in his attempt. Dr. Wright's figure stands at Rs. 1,000 crores. In any case, it is a colossal figure which no single industry can equal. The total value of agricultural products of India is said to stand at Rs. 2,000

crores. Animal husbandry, therefore, is economically as important as the growing of crops or plant husbandry.

The figures arrived at by Sir Arthur Olver and the data upon which they were based, and the checked figures and bases of Dr. Wright's estimate are instructive to the student of animal husbandry in India. The figures are based on the prices of 1929, although worked out in 1933. The earlier basic prices were chosen because of the economic depression and consequent up-setting of prices in about 1933.

355. Value of cattle labour for cultivation—612 crores : This was based upon the cost of maintenance of the working cattle per acre. The cost varied from Province to Province. For some tracts of C. P., Berar, Bombay, Bihar and Orissa, the average cost was stated to be as high as Rs. 25/- per acre ; it was Rs. 26/- in Madras and Bengal ; while in the United Provinces and the Punjab, the cost worked out as low as Rs. 14/- to Rs. 15/-. A flat average of Rs. 17/- per acre of cultivated area was taken. The total cropped area in India was 360 million acres. On this basis the cost of animal labour worked out at Rs. 612 crores.

This estimate is checked from another point of view. The cost of cattle labour is said to be 40 % of the value of the out-turn. The value of the total crop was estimated by the Banking Enquiry Committee at that time, and was stated to be Rs. 1,300 crores at pre-war prices. There was a rise of 20% over pre-war prices in 1929. Therefore, the Banking Enquiry Committee's figure, brought down to 1929 prices,

came to Rs. 1,560 crores. 40% of this came up to Rs. 684 crores per annum. The figure of Rs. 612 crores on the basis of cultivated area was, therefore, confirmed by the calculation based on the value of the out-turn, and was a moderate one.

556. Contribution by transport—161 crores : In addition to the use of cattle for cultivation there was another utility, that of transport, to which the bullocks were put. The Economic Enquiry Reports gave some figures about the cost of cartage of agricultural products to the markets. On an average, it may be estimated at one anna per rupee of the cost of production. This worked out at Rs. 146 crores. For other purposes to which bullock transport was used, the figure might be put at one-tenth of the above, or at Rs. 15 crores. The two items together for transport came to Rs. 161 crores.

357. Contribution by milk—810 crores : It was estimated that roughly 10 ounces of milk were consumed per head by the population as liquid milk and milk-equivalents in the form of *Ghee*, *Khoa*, sweets etc. This gives 39 million tons or about 1,000 million maunds of milk. The cost at $1\frac{1}{2}$ anna per lb. worked out to Rs. 810 crores.

358. Contribution by manure—270 crores : Dr. P. E. Lander, Agricultural chemist to the Government of the Punjab, calculated that a full-grown animal yield about 4 tons of dung and 3,347 lbs. of urine. These are utilised as manure or are burnt as fuel. To whatever uneconomic use they might be put at the time, these have an economic

value, though partly potential. Taking Rs. 14/- as the value of 4 tons of manure and Rs. 12/- as the value of urine, the total worked out at Rs. 26/- per animal per annum. From this a flat figure of Rs. 13/- per head was taken for the 198 million bovines. This came to Rs. 270 crores. Goats and sheep yield some manure also, and taking 10 goats or sheep as equivalent to one head of cattle, the value came to Rs. 12 crores which was not taken into account in Rs. 270 crores. (30)

359. Value of other products—55·5 crores : The Hide Cess Enquiry Report estimated the average life of a buffalo or of a cow to be 5 years, of a goat 3·8 years. The weight of hides and their prices were calculated as under :—

Buffalo	24 lbs.	per animal	at Rs. 40/-	per cwt.
Cow ...	15 lbs.	„ „ „	Rs. 40/-	„
Goat ...	2 lbs.	„ „ „	Rs. 60/-	„

The total for all animals came up to Rs. 30 crores. Assuming that 30% of all the hides were wasted and had no economic value, this had to be taken off from Rs. 30 crores. The net value stood at Rs. 22·5 crores.

Wool : On a basis of 3 lbs. in average of wool per sheep and at 4 annas per pound the item worked out at Rs. 3 crores.

Meat : Assuming 10 per cent of mortality among bovines, and 70 per cent of the sheep and goat were due to slaughter for meat, and calculating at Rs. 10/- per head of cattle and Rs. 7/- per sheep or goat

(based on special enquiry), the assessment of this item came to Rs. 20 crores.

Bone : Bone-meal and horn are exported, and their value came out to be Rs. 1·7 crores. Assuming that five times as much again remained in the country, this item came to Rs. 10 crores.

The foreign trade of live-stock came to Rs. 0·36 crores annually. The inland-trade value was excluded for assessment.

The several items then stood as under :

	Crores.
1. Cattle-labour for agriculture. ...	Rs. 612
2. Labour other than ,, ...	Rs. 161
3. Dairy products. ...	Rs. 810
4. Manures. ...	Rs. 270
5. Other products—	
Hide. 22·5 crores	
Wool. 3·0 ,,	
Meat. 20·0 ,,	
Bone etc. 10·0 ,,	
	<hr/>
	Rs. 55·5
6. Living animal export trade. ...	Rs. 0·36
	<hr/>
	Rs. 1,908·86 crores.
	<hr/>

The figures worked out at roughly, say Rs. 1,900 crores.—(*Olver & Vaidyanathan*)

360. Dr. Wright's estimate of contribution : Sir Arthur Olver had come to the conclusion that cattle labour was to be assessed at Rs. 17/- at a flat rate per acre for the whole of India.

Alternatively, he based his calculation on the assumption that 40% of the cost of cultivation went to meet the expenses of animal labour. Dr. Wright informed us that this figures had been arrived at as a result of an enquiry in the Punjab. Assuming that the total value of agricultural produce was Rs. 2,000 crores, the cost of cattle labour stood between Rs. 300 and 400 crores. The total value of agricultural produce was assessed by Findlay Shirras in 'The Science of Public Finance' at Rs. 1,983 crores for 1922. According to Mr. Vaidyanathan, this had risen to Rs. 3,400 crores in 1929 and had fallen to Rs. 2,000 crores in 1936.

Dr. Wright took an alternative standard also for evaluating animal labour. The basis was the cost of maintenance of a pair of bullocks. This was estimated at Rs. 175/- per year. With a pair of bullocks 10 acres could be cultivated. Therefore, the cost per acre came to Rs. 17.5. Multiplying this by the 300 million acres cultivated, the figure obtained was Rs. 525 crores for all India, or Rs. 400 crores for British India. This figure Dr. Wright accepted as against the Rs. 612 crores of Sir Arthur Olver's estimate. The latter had added to this the transportation costs. But Dr. Wright did not take labour other than agricultural labour into consideration. Therefore, Dr. Wright's 400 crores of rupees stood against the 612 crores of rupees plus 161 crores of rupees of Sir. Arthur Olver for animal labour.

361. Value of dairy products—Wright : The assessment of dairy product was very high as taken by

Sir Arthur Olver. He started with 1,000 million maunds of milk; as against that Dr. Wright accepted the newer figure of 700 million maunds which he valued as under at Rs. 300 crores.

TABLE—22

*Total value of milk & milk products
produced in India.*

Products.	Maunds of milk equivalent (million).	Retail value per maund of milk. Rs.	Value (crores of rupees).
Liquid milk ...	215·0	5	107·5
Ghee ...	364·0	2 $\frac{3}{4}$	100·0
Khoa ...	52·2	7 $\frac{1}{2}$	39·2
Other products...	16·7	13	22·3
Dahi (curd) ...	26·2	7 $\frac{1}{2}$	19·7
Butter ...	10·3	3	3·0
Cream ...	2·8	3 }	1·7
Ice-cream ...	2·8		
	<hr/> 690·0		<hr/> 293·4

—(P. 160. Wright's Report).

362. Value of manure—Wright: For manure Dr. Wright's figure was the same as that of Sir Arthur Olver, and stood at Rs. 270 crores.

363. Value of other animal products—Wright: This was assumed to be very nearly the same as that assessed by Sir Arthur and put down at Rs. 30 crores. The totals stood at Rs. 1,000 crores as against Rs. 1,908 crores. The figures in crores of rupees are put side by side below :

364. Olver and Wright estimates compared :*TABLE-23*

	Olver.	Wright.
1. Animal labour for agriculture.	612 crores	400 crores.
2. Labour other than agriculture.	161 „	...
3. Dairy products.	810 „	300 „
4. Manure.	270 „	270 „
5. Other Products.	55 „	30 „
Total—	1,908 crores.	1,000 crores.

365. Wright's valuation of liquid milk :

Dr. Wright had assessed liquid milk at Rs. 5/- per maund. In cities the price is much higher. But the cities consume only a fraction of the total production. In interior villages in seasons when milk is abundant cow milk is sold at $\frac{1}{2}$ anna per seer. But this has no bearing on the production cost, milk being regarded only as a by-product. Considering that in all-India estimates of milk, account was taken of both cow and buffalo milk the price is averaged for both kinds of milk. If milk is calculated at Re. 1/- per maund per cent of fat content, then cow's milk comes to Rs. 4/- having 4% of fat and buffalo milk with 6% fat comes to Rs. 6/- per maund. The two together bring the price to Rs. 5/- per maund, the figure taken by Dr. Wright for mixed milk.

About the value of manure it has to be remembered that it was a potential assessment. At present when

so much is wasted as fuel, its value may not be assessed at Rs. 270 crores. But its potential value as manure has been very modestly estimated at Rs. 270 crores. In Dr. Voelcker's Report in this connection, it has been calculated that the value of the daily out-turn of cattle manure should be assessed at one crore of rupees or Rs. 360 crores per annum. (Para-30)

While Sir Arthur Olver and Mr. Vaidyanathan had assessed the economic return from live-stock to be equal to the value of agricultural products, Dr. Wright's estimate brought it down to half. Even this half, or rupees one thousand crores, was an enormous sum. Any slight increase in it is bound to reflect itself in better living for the men engaged in animal husbandry and dairying.

366. A hundred per cent increase : But, it is not the increase of a fraction but of a hundred per cent that may be envisaged. The production of milk might easily go up to at least $2\frac{1}{2}$ times within a few years, and that one item alone will enhance the contribution by another 450 crores of rupees. Composting will certainly double the manurial value of dung singly used. Composting will allow the utilisation of all wastes and refuses from the household, and convert them to highly priced manure. That way Rs. 270 crores might easily double itself and allow 270 crores to be added to the 450 crores of rupees increase in the value of the milk-yield.

Manure and compost while put to the soil will help the raising of more crops, enabling cultivation of fields more than once in the year. This will

necessitate the greater employment of animal labour for cultivation and, therefore, will reflect upon the assessment of values, standing at Rs. 400 crores in Dr. Wright's estimates by increasing the figure allocated for animal labour for cultivation.

Dr. Wright had not assessed the out-turn of animal labour put to industrial uses, such as for the purpose of pressing oil seeds. Even at present a good deal of oil-pressing in the bullock-driven *ghani* is going on. If the export of oil seeds is to be replaced by oil-pressing then so much more mechanical labour will be necessary. Under appropriate Government guidance and help the whole of this increased power required for oil-crushing might be assigned to the bullocks.

In this way another 1,000 crores of rupees to the credit of animal husbandry is quite a practicable proposition, bringing up the total to Rs. 2,000 crores. It is not intended to pitch this figure against the present value of agricultural out-put. For, the very processes that will double the animal husbandry figures will also vastly enhance the out-put of agricultural products. Better manuring, better cropping, and more sowings on the same land will increase the acreage equivalent and pile up the figures for plant husbandry products. (302)

THE FUTURE BECKONS: There is so much to be done, and so little has been done, that the figures may induce hope in the aspirants for animal husbandry work and inspire them to take this neglected work with determination. What industry is there in India that can approach the combined

figures for the animal-cum-plant husbandry out-turn ! All other industries pale into insignificance before the magnitude of these. The vital necessity of the improvement of these two basic industries becomes pressing.

With the excellent breeds of cattle still existing in India, the animal husbandry products may assume much greater importance in India than in other countries.

The Cow In India

VOL. I

PART-II

HOW TO SAVE THE COW

CHAPTER VIII

FEEDING—THE INITIAL PROBLEM

367. Causes of deterioration : Deterioration of stock set in India after the commencement of British rule. It has already been explained that the village-centered civilisation was upset and a new education introduced which put new values and destroyed the old normal working life. (13—17) The causes of the deterioration of the cow can be traced to these factors. The deterioration continues. There have been added factors—increase of population and consequent decrease of pasture, the exaggerated importance of money crops, the ruin of village industries, the artificial importance created for the buffalo by the expansion of the export *ghee* market of the favoured provinces through cheap rail transport, the curtailment of work for the bullock by the introduction of power transport. All these have contributed and have been contributing their quotas for the deterioration of the cow. Above all, lack of village-mindedness has done the greatest harm to rural life, and the deterioration of the cow is only one symptom of the general unhealthy and abnormal condition of things in India.

368. Human population increased, not cattle : To save the cow from this deterioration will require the undoing of the evil forces that have been operating

so long. To save the cow, which means saving the nation, this very difficult and up-hill work must be undertaken.

The population in India has increased, but the milch and draught animals have practically remained stationary during the last twenty-five years. This itself would be a disquieting factor. The average of life of a cow has been estimated to be only five or six years. There is no reason why it should not be ten years. The cow has to be lifted up from the ruinous deterioration into which it has fallen. If this is not done, the whole social structure remains imperilled. If the cow dies, human beings also die in India. The two are indissolubly connected. In the dazzle of the newer values of life which contact with the West has brought, the fundamentals have been neglected and belittled. The deterioration has gone too far, and its effects are apparent even to the most superficial observer in malnutrition, squalor, disease and death.

369. Genetical knowledge of the past breeders : There is no doubt that cattle-breeding was in a very high state of development in India. Modern enquiries have proved that. The science of genetics was not known, but genetical practices in India were scientific. The breeder knew by their accumulated practical experience those truths which the science of genetics are now establishing. The tribes of people who brought the Indian cows to their excellence are fast disappearing, and in most places they are extinct on account of the change of attitude of the people to the cow, and to superior breedings. The rich men of

the past took care to breed high class cattle, they took pride in them and fostered careful and scientific breeding. But the times have changed.

Sir Arthur Olver writing about the *breeder of the past* paid this tribute to them :

“To have established such well-marked breeds, as for instance, the Kankrej, Kangayam, and Ongole breeds, long-continued and careful breeding to a definite type, with rigid elimination of every variation, must, however, have been practised, and it is clear that this work must have been carried on from generation to generation.” (11, 144, 175, 187)

370. Genetics cannot be learnt merely by experimental study : “Such work is largely a work of time and practical experience and cannot be learnt entirely by the experimental study of genetics in smaller animals or plants, however valuable such study may be in explaining the results obtained.

“Owing to the time and expense required to work out genetical factors in slow breeding and costly animals, live-stock improvement among the larger domesticated animals has still to be based on the breeding practice of the outstanding breeders of all times, which has now become traditional, and the fine points of which can only be appreciated by those who have a natural flair for breeding, and who have acquired an intimate knowledge of the class of stock concerned by practical experience.” (11, 144, 175, 187)

371. Indian breeders understood fundamental principles : “It is evident however that the breeders

who were capable of producing such even results must have thoroughly understood the fundamental principles which underlie all successful breeding of the larger domesticated animals, and judging from the care with which they still look for traditional breed-characteristics in the selection of their breeding stock, there is no doubt that this knowledge is still fairly widely applied by practical breeders in India, particularly among the professional cattle-breeders, who maintain considerable herds in large grazing areas, and are able to keep them reasonably free from the accidental intrusion of alien blood." —(*Agriculture & Live-stock in India. January, 1931*)

These discriminating races of cattle-breeders are dying out every decade, and the position has deteriorated much further during the decade that has passed since Sir Arthur Olver wrote the above.

It is a fact that cattle-breeding was in a highly developed state, and the practices of the well-known and recognised breeders were taken as models by villagers and there was a general tone of improvement working throughout. In this country every agriculturist is a cattle-breeder. He has to be one out of necessity. The knowledge of breeding techniques was, therefore, fairly wide-spread in India, although the professionals excelled in the art of breeding. (11, 144, 175, 187, 372)

372. Neglect of the female cow : All that is gone today. A wretched mentality of neglecting the female of the cow has spread over the land, and the breeding of the *she-buffalo* for milk has not a little

contributed to this catastrophe. The female of the cow is practically universally neglected, while the female of the buffalo is taken care of. But those who care for good breeding do take all possible care of their breeding cows as will be evident from the practice of the *Kangayam breeders*, where very generally a female is not parted with. The *Malas of Nellore* know how to take care of the Ongole heifers, because their profession and livelihood depend upon the rearing of good heifers for milk. Generally speaking, however, the cow, the mother of the bull and the bullock, is neglected.

Throughout India in all the *seven tracts* that were enquired into in 1937, the cow got the leavings of the working animals. The cow and the female-calf were left to eke out their living from what they could find by grazing with an occasional bundle of cereal stalks thrown to them—this was the sad story in the Punjab and the U.P., in Bombay, Madras, C.P. and the N.W. Frontier Province. The Royal Commission also found that this unfair treatment was meted out to the cow.

“...But when the census figures are used with the caution that is required, they clearly point to the conclusion which was borne out by the evidence which we heard all over India, that the cow, when dry, is the most neglected animal among cattle...”

—(P. 183).

“...it is not necessary to describe at any length the treatment of the cow. Broadly, it would be true to say that, if there is any fodder available after the draught cattle are fed, she gets it, or shares it with young stock ; for the rest she is left to find

food where she can. Where the cow provides some milk for the household as well as for her calf, cultivators try to spare her two to three pounds of a mixture of cotton seed and bran, or oil-cake, or pulse ; but, when her milk fails, the ration is withdrawn, and she is turned adrift to find a living for herself on 'grazings'. ..."

"The she-buffalo, rather than the cow, is the milk-producing animal of India.....Her treatment is very different in most localities from that of the cow. She is carefully tended by the women of the household, and not infrequently selection is exercised in her breeding. ..."—(P. 196)

That the race of the cow should be going down under such treatment is no wonder. (219, 236, 257, 278, 303, 371-'76)

373. Neglect of women : The *Enquiry Report* on the *seven breeding tracts* brought out another equally distressing factor about the neglect of the females among men and cows. This time it is the neglect of the females among human beings. Milk is a great item in the maintenance of health, and apart from its caloric value is a prime supplier of the vitamins and is an essential and supremely valuable food accessory. Because it is so important an item of food the discrimination in its use in the family is most strikingly painful. But the fact is there. The summary of the Report (I.C. A. R. 8-22.) said :

"When the consumption of fluid milk is analysed it is found that the male members of the family get more than the females " (219 236. 257. 278, 303, 372)

374. Consumption of milk & milk products, per head per day in ounces among total population.

TABLE—24

Fluid Milk	Montgomery.	Haryana.	Kosi.	Bihar.	C. P.	Bombay.	Ongole,	India—seven
			U. P.			Madras.	breeding tracts.	
Adult (M)	8.17	9.36	9.40	6.90	3.51	7.20	0.87	6.63 Adult (M)
Adult (F)	4.88	5.93	4.30	1.40	1.52	4.45	0.51	3.34 Adult (F)
Child (M)	6.48	4.73	7.30	8.10	4.21	6.90	2.00	5.82 Child (M)
Child (F)	4.34	3.57	4.30	3.10	3.24	6.00	1.90	3.77 Child (F)
Infant (M)	3.08	1.49	4.10	5.60	2.67	3.80	6.60	3.77 Infant (M)
Infant (F)	2.21	0.98	2.40	2.80	1.63	3.60	6.10	2.53 Infant (F)
Per capita	6.14	6.76	6.90	4.80	2.79	5.96	1.36	5.05 Per capita
Ghee	0.05	0.002	0.08	0.04	0.19	0.35	0.28	0.13 Ghee
Butter	0.67	0.36	0.05	—	—	—	—	0.17 Butter
Curd	0.32	0.36	0.02	0.10	0.53	0.02	2.10	0.22 Curd
Skim-milk	12.61	16.80	8.20	0.60	1.30	4.06	16.90	8.75 Skim-milk
Total. M.E.	15.53	12.39	9.71	5.51	6.73	12.07	8.73	10.16 Total M.E.

M. E.—Milk Equivalent. F.—Female. M.—Male.

—(Seven Breeding Tracts Enquiry.—P. 12) (219, 236, 257, 278 303, 372)

375. The female of man and of the cow should not be at a discount : It is not owing to the fact that the caloric requirement is smaller for the female that this discrimination is made, for even in children and infants the difference is equally persisting. The male sex is held at a premium and the female at a discount. In the human family the mother is the distributor, and it may be natural for her to allow more ration for the earning male and the working male child. That even can be understood, but the difference is inexplicable when it filters down even to infants ! It is a social evil persisting without the males caring much about it. As, however, the enquiry has brought it out, the evil must be faced, and the female of the human and of the cow should not be suffered to be at a discount. At present she is, and the result must be the same vicious circle which we deplore in many other matters. A weak mother gives rise to a weak progeny, and a weak progeny propagates still weaker off-springs. This state of affairs must be exposed and radically cured. If any one is to be better cared for, nursed and reared, it is the mother and the would-be-mother. Upon her health depends the health of the entire future family and, therefore, of the race.

The *she-buffalo* being an earning member is accorded the same treatment as the male working member. This is easily understandable. But will the *she-buffalo* be able to maintain the family of the cultivator with the increasingly stunted growth of the males of the cow ? The male of the *she-buffalo*

is of little use in cultivation ; and that it can be allowed to die without loss to the milk-yield is an additional inducement for keeping the she-buffalo for milk. (219, 236, 257, 278, 303, 372)

376. Bestow the same care on the cow and the buffalo : This injustice should have to be rectified in order to save the cow. The female of the cow must at least have the same care in feeding as is given to the she-buffalo, if not more. Ultimately it is bound to repay many times. It will be a step towards stopping the deterioration of the cow. It might be argued that the cultivator is too poor to feed the cow. It is true. Means should be found for feeding. But it is the mentality that has to be changed first ; for, if this mentality is not changed, any little extra facility will, under the present circumstances, go to feed the she-buffalo, keeping the cow as starved as ever. The mental attitude that in order to save himself the cultivator should better feed the cow, is to be developed. Undoubtedly, this atmosphere of neglect for the cow should be lifted off all over India. The Government-sponsored cult of regarding the ox as the draught-animal and the she-buffalo as the milch-animal must be fought out and given a burial.

This division between work-animal and milch-animal is a pernicious one. It easily leads to the attitude of neglect of the cow. For, the female of the ox, the cow, is neither a draught-animal and, according to the modern trend, she is not, or rather should not be a milch-animal. Her milk-yield is

poor principally because of neglect, but constitutionally also her milk has less fat than buffalo milk. The value of *fat in milk* has been over-emphasised. Milk from which the fat is taken out at once loses caste, and becomes almost an untouchable. Skimmed-milk has practically no value in the eyes of the public and in the eyes of law. At Calcutta any one selling *chhana* (milk proteins), made from skimmed-milk, as skimmed-milk *chhana*, is liable to be prosecuted. Skimmed-milk has no legal standing although its nutritive efficiency is at least 50% of the whole milk. This subject of *milk regulation* will, however, be dealt with in connection with dairying. (109-'27, 219, 236, 257, 278, 303, 372)

377. Cow milk better than buffalo milk : To come to our point. The cow gives milk which has a lower fat-content than buffalo milk. If this is regarded as a weak point in the cow, this weakness will have to be tolerated. But it is no weakness. Cow milk is better milk despite its lower fat-content. It is more suitable for children and the invalids, as compared with whole buffalo milk. But buffalo-milk as such is rarely seen in the market. All buffalo-milk is watered down and then sold as standard milk, or "mixed milk", or as cow milk; mostly as cow milk.

The neglect of the female of the cow, based upon this wrong valuation and the premium given to the adulteration of buffalo milk should go. Legislation about prevention of adulteration and the passing of the watered buffalo-milk as cow-milk would partly

take away the preference for the buffalo as the supply-animal for fluid milk. (109-'27, 520)

378. Buffalo problem absent in rural Bengal : There is, no doubt, that the cow should be lifted out of the unfair competition, where such competition exists. But there are areas, such as rural Bengal, where amongst the rural population the cow is the only milch-animal. There also the differentiation between the male of the cow and the cow herself is very much in evidence, no less than in other provinces with large she-buffalo populations. This inferiority stamp on the cow, as compared with the working-bullock, must go in the interest of the breeder-cultivator himself. If the cow is better fed she will give better and more valuable bullock and more milk.

It is a platitude to say that the constitution of the mother is the foundation upon which the whole structure of cattle-breeding is built. Therefore, the cow must be properly fed in order that she might present stronger and better bulls and bullocks, and reward the owner with more milk. (109-'27, 347)

379. Cow will respond to better treatment : It does not matter whether the cow is of a recognised breed or is a non-descript one. Feed her and she will be much better than otherwise : for verily, the cow is a very responsive animal. She may herself in some cases be unable to give more milk. The strain on her from her birth and during her formative age may have so adversely affected her constitution that even better feed cannot make her a much better milker.

But with better feed the calf to be born will start with a better chance and will certainly do better as a cow or a bull or bullock than if the dam were treated otherwise. (22, 127)

380. The cow as an economic animal : Looking at the cow purely as an economic animal, two aspects present themselves—she as the milking animal contributing to the health or wealth of the owner, and secondly, as the mother. The earlier she comes to calving the more valuable economically she becomes, and the oftener she calves subsequently, she gives greater returns.

With an ordinary ill-fed cow to start with, the economic factors are found to be low. It is an axiomatic truth that the cow will put herself to economic use after she has been able to maintain herself. The ordinary village cow in her fight to live is forced to curtail her economic factors. In other words, (a) early maturity, (b) reduction of calving intervals (c) milk yields, all that go to make the cow more and more economically valuable, are curtailed by the cow in order simply that she might live on. Nature prompts her to do so. When under-nourished she will defer her coming to heat. If she comes to heat and conceives at an early age, in the strain of carrying a calf she might kill herself. Nature protects her against such an emergency. She simply does not receive the call from Nature to come to heat. She consumes food year after year, and then in her fourth or fifth year she comes to heat to discharge her function as a mother. This does not pay the owner either, who

has to keep her alive whether she comes to heat or not. Now, in the normal course a cow may come to heat in two years and two months, and when she defers this to her fourth year, she uselessly consumes her food for the extra two years. If what she had been consuming during these two barren years had been put into her in the beginning, she would have borne a calf earlier and thereby more than paid for the extra feed that was normally withheld from her. By this treatment both the cow and the owner suffer. Because the cow suffers she causes extra suffering or loss to the owner. An unproductive cow is a drag on the breeder, although by delaying maturity she saves herself from strain and preserves her life. (22)

381. Ill-fed cows curtail economic factors : An ordinary cow, in her fight for living, or in her struggle for existence, becomes forced to curtail her economic factors.

This proposition has nothing to do with her breed or type. She may be from a good breed or she may be a non-descript cow. But the rule applies to all. As a non-descript cow of no particular breed, she might, when well-fed, come to heat in the normal time as other well-fed cattle of the locality, be it 3 years or 4 years. By under-feeding she delays and crosses over the time normal for her environments and her descent. Similarly also the two other factors of calving interval and milk-yield are interfered with.

If she is of a normally poor milking strain, under-feeding will make her a poorer milker, and if by her

descent she is normally a two-year interval calver, she will in her struggle become, say, a three-year interval calver to save herself. It is no good blaming the cow or her heredity under the above circumstances. These are physiological factors to which she must respond.

If the cow has in her struggle curtailed her economic factors in proportion to the adversity of her environments or management, an alteration of management or environments will naturally make her respond and lead towards increasing the economic factors—early maturity, shorter calving interval and greater milk-yield. (22)

382. Improvement of the scrub cattle maintained for manure only: In many parts of the country large herds of cattle are maintained by the farmers only for the manure that is got out of them. They are neither well fed nor cared for. They are generally let out in the village fields when not under any crop, and allowed to scrape whatever they can get or roam about on the village commons. No care is being taken about their breeding. Any scrub bull of whatever age is allowed to serve, producing a degenerate progeny. The cattle are penned up at night to collect their droppings. They never get enough food, neither are they given anything at home. They are always starved. The young male when it becomes fit for the plough is castrated and used in the farm. The rest carry on their miserable existence. Epidemics or even common ailments greatly keep down their number by heavy mortality. This is

not cow protection or cow-keeping. Cow-slaughter is any way much better than this perpetual starvation and life of agony. Efforts are necessary to stop this. This practice should be penalised. The manure for which all this is done is also not cared for. The dung part of it is clumped in a heap to be washed away by rain or burnt up by a strong sun. The urine is all wasted, there being no arrangement and effort to collect it.

Most of these animals, if properly handled, have a place in village economy. Let the farmer maintain only those animals that he can look after or properly feed. The herd must be headed by a good bull. All the manure should be scientifically collected and used on the farm. The manure from a few well-fed or well-cared for cows, if properly used, is always more in quantity and richer than that obtained from a big herd. The unproductive animals should be stopped from reproduction, and allowed to die a natural death. Care should also be taken that no unremunerative animal is born in the herd, *for an animal that is not born is never slaughtered.*

This will not only give the farmer the manure he needs but will also make available more and better bullocks for the farm, and milk and *ghce* for the home as well as for the market.

Experience has shown that when the village cows are well-fed and well-looked-after, they not only produce more and better milk, stronger calves, but mature early and breed regularly, and thus instead of

becoming a burden become "Kamdhenus,"—the fulfiller of all wishes. (22)

383. Give the starving cow a start : But, if the constitution of the cow had gone already against her, the breeder should yet care for her so that she may start her progeny and arrange to give the calf in the womb such a constitution that it might be more valuable economically than its dam. Body-building commences before the calf is delivered, and care should begin as early as possible after conception to get a better off-spring than the dam. From this point of view, it may be said that in adverse environments the starting-point is not the dam but the calf or the would-be calf in the mother's womb.

The environments, mentioned above, are adversity of climate, the prevalence of diseases, parasites, ticks, malnutrition, deficiency of fodder in quantity and quality, etc. Skilful management may go towards rectifying these defects in a large measure. (22)

384. Calf-management for a better future : It is very generally the case that the owner in his attempt to make a profit out of an uneconomic or poor animal, reduces calf-management to the art of keeping it alive with the minimum quantity of milk. In towns, where the cost of maintenance is high, this tendency is further exaggerated, resulting in high mortality among calves. Those calves that come out of the ordeal become stunted creatures with no future. Calf-management will include giving plenty of sustenance

to them, milk and later on skimmed-milk. Calves cannot digest anything but milk for a certain period, and their stomachs do not get formed for digestion of grass at their birth. For a time the calf is to be maintained on milk with added gruel as their age advances. A guide for checking whether a calf has been getting proper nourishment consists in finding the rate of its increase in weight. For every animal there is a period in which it doubles its weight after birth. (22)

385. Table: Days for doubling the weight of new-borns:

TABLE—25

Animal.	No. of days for doubling weight of new-borns.		Protein-content in milk.	
Man	...	180	...	1.6
Horse	.	60	...	2.0
Cow	...	47	...	3.5 (European)
Goat	...	22	...	4.3
Sheep	...	15	..	6.5
Pig	...	14	...	6.7
Dog	...	9	...	7.1

It will be seen from the Table that growth depends upon the protein-content of the mother's milk.

The calves of European cows double their weight in 47 days. In other words, if a calf is 40 lbs. in weight it will add another 40 lbs. approximately in 7 weeks, or the rate of growth per week will be approximately 7 lbs. For Hariana cows the rate of

growth for the first year is 8 lbs. increase per week. This is probably due to the fact that the milk of Indian cows is of about 5% fat-content against 3.5% of European cows. The *birth weight* of a calf varies with the breed and constitution of the dam. But the breeder has to see that the calf is increasing in weight according to schedule. If the calf is abnormally lean at birth, the rate of growth will be proportionately fast to make up for the initial deficiency.



CHAPTER IX

MEETING FODDER DEFICIENCY

386. Fodder Deficiency : The cows are not given a fraction of the nutrition they need, and even the work-cattle cannot be properly fed. This is so because there is dearth of fodder. During rains, in certain localities, there is plenty of growth of various grasses, good and bad. If this could be converted to hay, it could go partly to relieve the want of fodder. But unfortunately this is not practicable because grass at its best of growth cannot be made into hay, on account of the rains. When the rain ceases the grasses become inferior and less palatable to cattle.

In the Wright Report a Table of the available fodder supply is given which raises the question as to how the cattle can be fed in view of the very wide shortage. (21, 391, 591)

387. Wright's Table of available fodder :

TABLE—26

Total available feeding stuffs.

Fodder.	Available quantity (1,000 tons).	Total digestible nutrients. (1,000 tons).	Nutritive ratio.
Dry fodders	1,11,000	36,480	1 : 36·0
Green fodders	1,00,000	11,562	1 : 10·6
Concentrates	1,500	1,163	1 : 1·6
Cotton Seed	2,300	1,818	1 : 5·1
Total —	2,14,800	51,023	1 : 17·5

215 million tons of fodder for 215 million heads of bovine and ovine cattle of British India work out at one ton per annum per head or $2\frac{1}{2}$ mds. per month or 3 seers per head per day, about half of which is green. This daily ration converted to dry fodder, would come to only 2 seers per head,

Even the very small cows of Bengal require 4 seers of dry fodder per day. Bullocks and buffaloes consume very much larger quantities; if goats and sheep are included, seven of these are calculated to be equal to one head of cattle of all ages. (21, 591)

388. Dr. Kehar's Table of fodder insufficiency: Insufficiency of total fodder in India was further tabled by Dr. Kehar, Research Officer, Imperial Veterinary Research Institute. (*4th meeting A. H. Wing, (1940).*—P. 197).

TABLE—27

Foodstuffs available per head of cattle

	Available in India in tons.	Available per animal per day for 214 million head of cattle.	Normal requirements for an ani- mal, 500 lb. body weight.
Total Digestible nutrients.	5,10,13,000	1.456 lb.	3.9 lb.
Total digestible crude protein.	27,63,000	0.079 lb.	0.3 lb.
Dry matter :			
Dry fodder	11,10,00,000	3.17	} 3.83 10-11 lb.
Green „	10,00,00,000	0.55	
Concentrates	38,00,000	0.11	

This Table will show the deficiency very clearly. Available fodder is less than even half of the required feed.

The Royal Commission appended to their Report a Table showing the estimated cost of maintaining a pair of bullocks for one year by a *ryot* in the various districts in British India. In this Table (389) the quantities of feed required are given divided into *roughages* and *concentrates*. *Roughages* mean the bulky food that provide the bulk and nutrition also. Rice straw, stalks of cereals and legumes, hay, green grass are roughages ; while cereals, pulses, oil cakes, oil seeds etc. are regarded as 'concentrates' or concentrated food.

The Royal Commission, while attempting to find the cost of feed, calculated what was to be fed according to the local practice, and not what was actually fed. The Commission put it thus :

"In asking the Agricultural Departments what it costs the average cultivator to feed his plough cattle, we set them a difficult task and their replies must be regarded more as an answer to the question 'How would the average cultivator like to feed his plough cattle?' than to the question 'How does he feed them and what is the cost ?' " (21, 591)

389. Cost of feeding a pair of bullocks per year.

TABLE—28

Province.	Kind (a)	Roughage. Qty. lb. per day & days fed. (c)	Value of roughage at local rates. Rs.	Concentrates. Kind (b)	Qty. lb. per day & days fed (c)	Value of concentrates at local rates. Rs.	Total value of roughage & concentrates. Rs.
MADRAS							
Tiruvallur. (Plough Animals).	R	25 × 365	46 {	O	1½ × 180	22 }	68
				Bran	3½ × 180		
Tiruvallur (Cart Animals).	R	25 × 865	46 {	O	2½ } × 365	91	137
				Bran	7 }		
Ramnad (Black Cotton Soil).	J	20 × 865	112	Cot. S.	6½ × 365	112	224
Madura	R	37 × 865	136	...	...	...	136
Coimbatore	J, B, R, & G. G.	36 × 365	144	Gdnt. C., Cot. S., Gr., & R.B.	...	116	260
Central Farm.	J, B, R, & G.G.	29 × 865	91	Do. do.	*	124	215
Pollachi				Gdnt. C.	3		
				Gram	2		
				R. B.	2		
				Salt	1/32		
Anakapalle	R	49 × 365	91 {			35 }	126

SIND

Nawabshah (Flow area).	K	$\left\{ \begin{array}{l} 40 \times 120 \\ 20 \times 90 \end{array} \right\}$	28	O	$\frac{1}{2} \times 60$	2	30
Nawabshah (Lift area).	$\left\{ \begin{array}{l} K \\ \text{Grazing} \\ \text{and G.F.} \end{array} \right\}$	$\left\{ \begin{array}{l} 20-40 \times 280 \\ \times 185 \end{array} \right\}$	$\left. \begin{array}{l} 30 \\ \dots \end{array} \right\}$	O	1×95	6	86

BOMBAY

Dharwar (Mallad Rocky tract).	$\left\{ \begin{array}{l} R \\ G. G. \end{array} \right\}$	$\left\{ \begin{array}{l} 32 \times 180 \\ 180 \end{array} \right\}$	$\left. \begin{array}{l} 36 \\ 34 \end{array} \right\}$	Cot. S.	4×150	30	100
Dharwar (Black soil).	$\left\{ \begin{array}{l} K \\ W \end{array} \right\}$	$\left\{ \begin{array}{l} 19 \times 865 \\ 20 \times 865 \end{array} \right\}$	$\left. \begin{array}{l} 60 \\ 72 \end{array} \right\}$	Cot. S.	6×183	43	175
Dharwar (Intermediate).	J	$\left\{ \begin{array}{l} 40 \times 183 \\ 20 \times 182 \end{array} \right\}$	68	Cot. S.	6×250	60	128
East Khandesh (dry).	$\left\{ \begin{array}{l} K \\ G. G. \end{array} \right\}$	$\left\{ \begin{array}{l} 31 \times 213 \\ 37 \times 152 \end{array} \right\}$	$\left. \begin{array}{l} 66 \\ 28 \end{array} \right\}$	Cot. S. or O.	6×243	45	139
West Khandesh (dry).	K, B, Gdnt. Fodder, Grass.	40×340	149	Cot. S.	4×121	19	168

Province.	Kind (a)	Roughage. Qty. lb. per day & days fed. (c)	Value of roughage at local rates Rs.	Concentrates. Kind (b)	Qty. lb. per day & days fed (c)	Value of concentrated at local rates Rs.	Total value of roughage & concentrates Rs.
BENGAL							
East (Dacca, Mymensingh, etc.).	R plus G.G. and Weeds.	2 × 180 *	45	Mus.	1 × 180	17	62
Central (Pabna and Nadia).	Do.	20 × 240 *	60	Mus.	1 × 240	20	80
West (Burdwan & Bankura).	Do.	20 × 270 *	69	Mus.	1 × 91	7	76
U. P.							
Meerut	J and W plus G. G. & Weeds.	20-40	45 {	O, Gr. Bhooni, Chuni.	4-8 × 365	72	117
PUNJAB							
Gurgaon	{ K W plus G.G. and G.F.	52 × 121 82 × 122	84 { 48 {	Gr. & O Gur, Ghi, and Flour	6 × 273 *	71 } 12 }	215
Lyallpur	{ W G. F.	16 × 365 1½ acre	53 { 90 }	Gr. & O	8 × 80	30	173

Montgomery	{ W G. F. }		10-40 × 365	106	Gr. & O	6 × 91	31	234
			*	97				
BIHAR & ORISSA								
Cuttack	R	16-20 × 865	56		R. Dust, Cr. P.	6 × 150	42	98
Saran	{ GF, Bhusa R, Bhusa, Cane Tops. }	80 × 152	48	*		4 × 152	24	187
		40 × 213	53	*		* × 218	12	
C. P.								
Wheat & Cotton tract.	W	80-50 × 365	158	*		8-6 × 800	53	211
Rice tract.	R	40 × 365	90	*		2 × 240	15	105
ASSAM								
Sibsagar	R	10 × 121	7		R. B.	4 × 121	8	15
Sylhet	R	16 × 152	19		R. B.	4 × 152	9	28
							—(21, 591)	

(a) Symbols used :— J—Jowar Kadbi ; B—Bajra Kadbi ; M—Millet (unspecified) Kadbi ; R—Rice straw ; W—Wheat bhusa ; G. G.—Green grass ; G. F.—Green fodder ; K—Kadbi (unspecified) ; S—Straw (unspecified).

(b) Symbols used :— O—Oilcake (unspecified) ; Cot. S.—Cotton Seed ; Gdnt. C.—Groundnut cake ; Gr.—Gram ; R. B.—Rice bran ; Mus.—Mustard cake ; Cr. P.—Crushed paddy.

(c) When the number of days for which feeding is specified is less than a year, the cattle spend the remaining days on grazings.

*No information.

390. What the Table showed : It will be seen on scanning the Table that a pair of working bullocks consumes about 40 lbs. of roughage per day in addition to concentrates. The Table gives figures only for a number of days in the year, and on the other days the bullocks graze and find their feed for which the cultivator has not to pay and which, therefore, does not come under cost calculation.

The production cost of dry and green fodder calculated in the above Table, left gaps for the grazing by which the cattle help themselves. Yet, with all consideration given and allowance made, the total of 111 million tons of dry and 100 million tons of green fodder are extremely inadequate for the cattle population of India. (21, 591)

391. Deterioration will be more wide-spread :
The Royal Commission observed :

"While the evidence of witnesses points to the probability that deterioration is going on, our own examination of the position, created primarily by the increasing demand for bullocks, owing to the extension of cultivation, leads us to the conclusion that conditions have arisen and are already at work which cannot fail to prejudice the live-stock, and that cattle such as the deplorable animals now to be seen, for example, in parts of Bengal and of the Central Provinces, must become more common unless substantial changes in the existing management takes place."

It was strange that the Royal Commission had stopped merely by mentioning the increasing demand

for bullocks for the extension of cultivation as one of the causes of the deterioration of the cattle. (21, 386, 591)

392. Normal rate of increase of cattle-population : Supposing that a cow begins calving under normal circumstances at the third year of her life and goes on giving a calf every eighteen months, and allowing a ten years span of life to her, it is found on calculation that in 10 years there will be 4 cows from one parent and her daughter cow, and in another 10 years each one of those four cows will give another set of 4 cows. In twenty years, therefore, there will be 16 cows from one cow, barring accidents. When the multiplying capacity of the cow is so great, it is strange that the cultivator has not been able to meet the demand for bullocks, and the price of bullocks, according to the Royal Commission, was going up because of the shortage of supply.

There is surely a shortage in the supply of bullocks, but the reason of the shortage is primarily in the cow—the weak and uneconomic, the underfed and uncared for, and the weedy cow, which begins calving late and gives only a few calves at long intervals in her life-time.

The cow is underfed and, therefore, there is the dearth of bullocks. The problem again goes back to the initial question of feeding. How can the cow and her progeny be fed.

393. Cow problem—avenues for solving it : In this matter statistics fail us. If it could point out some way, we could explore and develop that point. And it is because that statistics fail to give any

indication of the way out, that the Royal Commission left the cow problem as insoluble.

While the Royal Commission have failed, we cannot remain satisfied at that failure. Some way must be found. Dr. Voelcker had shown a way for the improvement of the cow. He was for saving cow-dung from being burnt and for using it as a manure for increasing crop-production. Increased crop-production would release some soil, and that could be transferred to the growing of fodder. That this is the most satisfactory and relevant solution, there is no doubt. And the major work in connection with this reform depended upon the Central Government. The Government having lost the inclination for helping the cultivator to obtain fuel practically free, little could be expected from that quarter.

But even this despair at the Government's failure to improve the cow, should have to be got over, and avenues have to be searched for feeding the cow and for stopping the deterioration. The people must find out some source of strength within their reach, by the application of which they may try to produce the effects opposite to what has led to the miserable condition of the cow. This is not inherent either in the Indian cultivator, the breeder of the cow. Circumstances have created the situation and avenues should be sought for creating the opposite of those circumstances that have led to the present ruinous state.

394. Indian cultivator knows how to make adjustments : The Indian peasant is not absolutely

helpless. When he becomes conscious of his needs and sees an way to adjustment, he makes that adjustment. The treatment accorded to the cow in the cotton areas and in the rice areas will help to throw light on the source of hidden strength for adjustment that the cultivator possesses.

395. **Illustrated from provinces :** In Madras, we have seen how the *ryots* in *Coimbatore* have changed a natural disadvantage into a bliss. The area is dry and un-irrigated. The cultivator, therefore, has taken to well-irrigation and also to animal husbandry. The pastures are fenced fields. They are rearing some of the finest cattle of India. While to the north in the same Province of Madras, we know of the Bhadrachalam cattle—the worst imaginable animals reared in the forest without care—weak and semi-wild animals that are sent to crowd the rice-areas of the delta.

Bellary and *Tanjore* districts in Madras show similar features. *Bellary* is a cotton area and *Tanjore* is a rice area. *Tanjore* supports four times as many cattle per cultivated area as *Bellary*. It is the character of the tilled soil and of the crops grown in *Bellary* and *Tanjore* respectively that decides the number of the cattle kept. *Bellary* grows hardly any rice, its chief crops are millets—1·5 million acres, and cotton—·5 million acres. In *Tanjore*, on the other hand, about 70 per cent of the gross area is occupied by rice, being 1·1 million acres, and the other crops are of very little importance. In *Bellary* the total stock of cattle is remarkably small, being 21 per

100 acres sown area, as compared with 66 for the whole of Madras Presidency and 108 for Bengal.

396. Grazing area not a decisive matter : It is, therefore, not exactly the want of the grazing areas that is a decisive matter with the condition of the cattle. It is a question of growing fodder as a crop or not growing it, and it is also a question of difference in nutritional value between rice-straw and *joar* or millet or wheat stalk. Rice areas, be they in Bengal, Madras, Malabar, or Kashmere or the Kangra Valley, are notorious for their poor cattle. Once it was thought that there was something in the soils most unsuitable for cultivation that suited the cattle. In other words, in the areas where there was abundance of rain-fall and seasonal grass the cattle were poor, and in the areas where there was scarcity due to absence of rain and correspondingly less yield of harvests from fields, the cattle thrive.

The explanation was sought in the fact that in wet areas with plenty of grass in season, the cultivator gets into the habit of not taking the trouble of growing fodder for the cattle to feed them during the dry season of scarcity of grass. Whereas, in the dry areas where it is all the year round difficult to get good grazings, the cultivator is forced to grow fodder and keep his cattle fit, and also to restrict their number to the minimum. (426-'39, 596)

397. Nutritional deficiency of rice-straw makes the cattle poor : Another factor, in my opinion a very important factor, is that the wet areas are invariably rice-areas. In the rice-areas, rice-straw is the principal

dry and preserved fodder. Rice-straw is very deficient both in proteins and in the suitable proportion of mineral salts. The digestibility of the straw as regards protein and mineral retention is strikingly small. The cattle kept on rice-straw are bound to be weedy. The cultivator does not know all this. He has never used nor can use any other dry fodder except rice-straw, and he is ignorant of its startling deficiency as a cattle-food. He is ignorant also of the fact that the deficiency of rice-straw can be corrected, and that the correction is within his means. It is this thing that accounts for the difference between the condition of the cattle in rice and non-rice areas. But along with this it must not be forgotten that the cultivator who is forced to grow fodder at the sacrifice of a money crop becomes zealous about how he maintains his cattle and the number he maintains. This is also one of the reasons, though not the only one, for the comparative difference in the size and strength in favour of the cattle in the dry areas.

After all these considerations, one may come to the conclusion that the position offers possibilities for improving feeding even where the Government may be ignorant or heedless of the welfare of the cultivators. In such an atmosphere the main problem is what can be done for reaching the *ryots* and for carrying conviction to them for changing their methods. (505, 655, 794-814)

398. **The gap between the Government and the cultivator:** The whole crux of the problem lies there. The Government, even when it is well-intentioned,

fails to reach the cultivator, despite all propaganda. The more propaganda the Government makes the more it is mistrusted, and not unoften reasonably mistrusted. The situation has come about by the same means which has emasculated India and made her a toy in the hands of the present regime. Pre-British India was not so; Pre-British Indian villages did not depend for their welfare entirely upon the Government, be it sympathetic or indifferent, alien or inimical. There was another State, and a much stronger State within the State.

A few passages from Elphinstone, written in the early days of the infiltration of British possession, of British culture and of the British system into India, will be appropriate to understand the strength that once was in the hands of the villagers and the loss of which accounts for much of the miseries of the present, times of which the neglect of the cow and fodder shortage are symptoms. I mean the destruction of the village communities. (18, 264-'65)

399. Village Communities : R. C. Dutt in his *Economic History of British India* quoted from Elphinstone's Report on the "Territories conquered from the Peshwa" Vol. IV. East India Papers as under :

"In whatever point of view we examine the Native Government in the Deccan, the first and most important feature is the division into villages or townships. The communities contain in miniature all the materials of a State within themselves, and are most sufficient to protect their

members, if all other Governments are withdrawn. Though probably not compatible with a very good form of Government they are an excellent remedy for the imperfections of a bad one; they prevent the bad effects of its negligence and weakness, and even present some barrier against its tyranny and rapacity.

"Each village has a portion of ground attached to it, which is committed to the management of the inhabitants. The boundaries are carefully marked and jealously guarded. They are divided into fields, the limits of which are exactly known. The villagers are almost entirely cultivators of the ground, with the addition of the few traders and artisans that are required to supply their wants. The head of each village is a Patil. There are besides twelve village officers well known by the name of Bara Baloti. These are the astrologer, the priest, the carpenter, the barber, etc. "

(525, 528)

400. Village Panchayet system of the past :

"But with all these defects, the Mahratta country flourished, and the people seem to have been exempt from some of the evils which exist under our more perfect Government. Therefore, there must have been some advantages in the system to counterbalance its obvious defects, and most of them appear to me to have originated in one fact, that the Government, although it did little to obtain justice for the people, left them the means of procuring it for themselves. The advantage

of this was particularly felt among the lower order, who are most out of reach of their rulers, and most apt to be neglected under all governments..."

"I propose, therefore, that the native system should still be preserved and means taken to remove its abuses and revive its energy....."

"Our principal instrument must continue to be the *Panchayet*, and that must continue to be exempt from all new forms of interference and regulation on our part." (25th October, 1819). (525, 528)

401. Re-establish the village communities : If there were village communities re-established in the villages, and if there were village *Panchayets* as the executive body of those village communities, then, under the present circumstances, some member of the *Panchayet* could make a journey to other tracts and see how they grew their cattle-fodder in lands which could grow such a money-crop as cotton or millet. The *Panchayets* would have learnt that feeding the cattle paid. For example, as against the Raipur cultivator's Rs. 105/- expense for the maintenance of a pair of bullocks, the Berar cultivator spends double, Rs. 211/-, (389) and on that account the cultivator is not insolvent, but keeps on some-how, perhaps is a little better than their fellow-*ryots* of Raipur villages. From a rice-tract, the *Panchayet* might not get what they got from a cotton-tract, but no doubt the rice-tract cultivator could very much improve his cattle and learn to use his forest or wastes as assets to be developed rather than find these as impediments. The members of the *Panchayet*

in rice areas can send one of their promising young men to the Provincial Agricultural Department, and learn all about the nutritional values of rice-stalk and their deficiencies, and the methods to correct those deficiencies by probably adding some measure of bone after crushing those bones that they find strewn about in the fields. Or, if their Hindu sentiment is hurt at that procedure, they could ask a *Chamar* to burn the bone, and give them the fire-purified chemical substance, bone-ash to correct his *rice-straw* feed. (525, 528)

402. What village community could do : The *Panchayet* could have accomplished all this, and from the *Panchayet* the matter would have come to the village community for adoption by the entire village, and could have changed the condition of their cattle. From one village community it could have spread to another, and the cow of Raipur could have been saved from the cruel goads, and lifted from its deplorable condition.

The critic might reply that the villager might do the same things today. There are the Union Boards in which every village is represented through its influential men, and then on the top is the District Board connected with the Secretariat, the very seat of Government authority. In fact, the villager is better linked to the Government today through the Union Board and the District Board than they were ever before. In addition to that, there are the Co-operative Societies to take up the monetary responsibilities of the scheme and new societies, in this particular

matter, the cattle-breeding societies are being fostered by the Government. (525, 528)

403. Why Union Boards & Co-operative societies are lifeless : All these are correct. But one thing is wanting. All these machineries are dead. They need life. They have been super-imposed upon the villager. These have not grown out of the hunger of the villager to create an instrument to serve his needs, but have been super-imposed by a Government which wants to closely watch all political growths in the country and control them for its own alien needs, and not for the essential and vital needs of the villager. This is the feeling of the people. This is what has made the present structure an instrument of compulsion rather than a hand-maid or a creation of the people.

The village *Panchayets* meant something more than a mere formal body, and the village community was village-life itself, its own blood and bone. It lived for the village and protected the village. The community expected no reward, feared no punishment. It was the collective village-life moulded into a communion. This has gone. It cannot be re-established by a legislative stroke of the pen. The Legislature might and did kill these communities ; but it is not possible for the Legislature to create them anew. These must spring out of the very blood of the people to serve the purpose they once served. (264-'65, 525, 528)

404. The handicaps of the present political situation : In the present temperament of the people, in the lurid glare of a dying civilisation, it is still a

most difficult matter for any living thing which is connected with their very life to go in the villages. The District Magistrate will at once look upon it as his rival ; and rival it will be, for, the interests are diametrically opposed. The Magistracy only knows the instruments of its own creation—the Union Boards and various Boards and Associations. One thing is essential about these—that they must be subservient to the Magistracy. If these are not subservient, they are likely to be dubbed rebels, and suppressed. It is true that no large measure of good, affecting the villagers' life can be accomplished without the institution of the village communities as they used to be in this land of ours. They grew and they thrived independently of the State. These cannot be a part and parcel of an alien Government. Apart from the opposition of the Magistracy to the creation of the village community of our ideal, there is a cultural bar also. The imported culture has taught the *intelligentsia* to regard poison as nectar, and the very life-giving nectar as poison. (525, 528)

405. **What village communities were :** The village communities and village *Panchayets* were based upon the idea of the self-sufficiency of the village as the quotation from Elphinstone amply shows. This theme was better advanced later on, and more forcefully, but also equally ineffectually, by Sir Charles Metcalfe, acting Governor-General of India, in his famous Minutes of 1830. The extract from Sir Charles' Minutes below is from R. C. Dutt's *Economic History of British India*.

“The village communities are little republics having nearly everything that they want within themselves, and almost independent of any foreign relations. They seem to last where nothing else lasts. Dynasty after dynasty crumbles down, revolution succeeds to revolution ; Hindu, Pathan, Moghul, Mahratta, Sikh, English are masters in turn, but the village communities remain the same. In times of trouble they arm and fortify themselves, a hostile army passes through the country ; the village community collects their cattle within their walls and let the enemy pass unprovoked. If plunder and devastation be directed against themselves and the force employed be irresistible, they flee to friendly villages at a distance, but when the storm has passed over, they return and resume their operations. If a country remains for a series of years the scene of continued pillage and massacre, so that the villages cannot be inhabited, the scattered villagers nevertheless return whenever the power of peaceable possession revives. A generation may pass away, but the succeeding generation will return. The sons will take the places of their fathers, the same site for the village, the same position for the houses, the same lands, will be re-occupied by the descendants of those who were driven out when the village was depopulated, and it is not a trifling matter that will drive them out, for they will often maintain their post through times of disturbance and convulsion, and acquire strength

sufficient to resist pillage and oppression with success." (525, 528)

406. Village communities preserved the people through revolutions : "The union of village communities, each one forming a separate State in itself has, I conceive, contributed more than any other cause to the preservation of the people of India through all revolutions and changes which they have suffered, and it is in a high degree conducive to their happiness and to the enjoyment of a great portion of freedom and independence. I wish, therefore, that the village constitutions may never be disturbed, and I dread everything that has a tendency to break them up. I am fearful that a Revenue Settlement with each individual cultivator, as is the practice in the Ryotwari Settlement instead of one with the village community, through their representatives the head men, might have such a tendency. For this reason, and for this only, I do not desire to see the Ryotwari Settlement generally introduced into the Western Provinces."

Romesh Chandra Dutt, the historian and the administrator who had worked the system that had destroyed the village communities, expressed the feelings of his people when he said :

"Sir Charles Metcalfe was correct in ascribing the disappearance of village communities in Madras and in Bombay to the introduction of the Ryotwari Settlement. When a settlement is made with each individual cultivator, the *raison d'être* of the

village community ceases. The endeavours of Munro and Elphinstone to keep the communities alive, after depriving them of their chief function, failed. In Northern India too the village communities have virtually disappeared within the last seventy years through similar causes." (525, 528)

407. How the village communities disappeared :

"The British Government in obedience to western ideas, endeavoured to fix the responsibility of land-tax on particular men, *zemindars* or headmen until they became responsible revenue payers and landlords, and the communities declined. And in trying also to centralise all judicial and executive powers in the hands of its own officers in the spirit of Western institutions, the Government withdrew or weakened the ancient powers of the communities, until they fell like trees whose roots had been severed. With the most sincere desire to preserve this ancient form of self-government, a desire earnestly and eloquently felt and expressed by Munro, Elphinstone, and Metcalfe, they nevertheless failed in their object, because they withdrew the powers of self-government from the little republics, because they centred all powers in their own civil courts and executive officers, because they reposed no real trust in the old institutions of the people. One of the saddest results of British Rule in India is the effacement of that system of village self-government, which was developed earliest and preserved longest in India among all the countries of the earth."

The village communities are by now wholly gone, and it is the very thing that could save the cow and save India too by taking some load off her miseries, and by strengthening the people. (525, 528)

408. Cultural conquest responsible for disappearance of village communities : Romesh Dutt attributed the extinction of the village communities to the swing of the revenue system from the old communal method to the Ryotwari System which deprived the village communities of their vitality, and also the introduction of the present system of revenue administration through Civil Courts. This is true but not wholly so. Another great contributory cause was the cultural conquest. What an Elphinstone or Metcalfe felt could not have been felt by the English-educated Indians, because they were blinded by the West. Even the evils of the West appeared to them to be good. This mental defeat, this want of appreciation of the old institutions of India, completed their ruin. If an appreciative mood revives in the *intelligentsia* today, if the old Indian institutions for maintaining the flow of Indian life, sweet and peaceful, are re-valued, then something great may again grow out of the present chaos. (525, 528)

409. Self-sufficient village to spring up to save : We want self-sufficient villages for saving the cow. And this self-sufficiency is no mere external substance that can be purchased or borrowed. A self-sufficient village will mean a denial of many things that are not essentials. Let each village or group of villages grow its own requirement of food-grains and fodder and

oil-seeds. Let each village or group of villages grow its own cotton, and then convert the cotton by spinning and weaving into cloth for the entire population concerned. The villages then become self-sufficient in the matter of food and clothes. Let each group of villages grow its own timber and bamboos and thatching-materials, thus providing the three primary necessities of food, clothing and shelter. (525, 528)

410. Cattle-rearing and revival of village communities : Growing food involves cattle-rearing for the plough and for the milk. And let every householder be a cattle-and-plant farmer, organising mixed farming for the villages. If these are accomplished, other things will come naturally to fit in with the scheme. A system of primary education will develop, as of old, which will be in living contact with village life, taking its inspiration and ideal from the village model and converting it to materials conducive to better living in every way. (525, 528)

411. Self-sufficient village through self-help : These do not require any money from outside. All that have been mentioned can be created from the soil by the labour of the population. The excessive stress on money will relax, and tend to place exchange on the healthy basis of barter. In such a scheme, the cultivator, the smith, the carpenter, the doctor and the veterinarian, the grocer and the carter, the *gowala* and the fisherman, the *chamar* and the tanner, the dyer and the printer, the paper-maker and the glass-maker, the potter and the oil-presser, the tapper and the

cane-presser and *gur-maker*, the wood chopper and the grass-cutter, the boat-maker and the boat-men, the brick-maker and the brick-layer, the stone-carver, the merchant and the dealer, the teacher and the pupil, the author, the poet, the artist and the painter, will all have their places of honour. Money or no money such a scheme will work automatically; any suitable measure of labour or material being used as the medium of exchange. (28, 444, 525, 528, 577)

412. Self-sufficiency scheme : If people agree to live a simple life, caring for the essentials, then it is possible to re-establish village communities and village *Panchayets*. The people may stand to lose quick transport and quick news-service, the radio and the cinema. But life will certainly not be the less enjoyable owing to their absence. And it is not that railways and the telegraph, the radio and the steam-ship cannot be fitted in with this scheme. They may and will remain devoid of their destructive character. And money too, devoid of its undue importance, will remain simply as the hand-maid and not as the master. (24, 26, 528, 544, 579)

413. No other way to save the cow : One may ask—must all this be done to save the cow? I am afraid, there is no other way. The Royal Commission, for example, could show no way whatsoever. The Commission could not find a way out because the Commissioners wanted to keep everything intact and yet elbow out a place for the cow. In that attempt they unfortunately leaned on the buffalo, resulting in elbowing out the cow still more.

If this marching on to the fundamentals of corporate living, assuring the primary essentials of life, is not liked, then there is nothing but death for the cow and the man—death sometimes slow and sometimes fast enough, but in any case, the march will be to destruction. Either to destruction or to the sustaining motherly breast of self-sufficient villages, enjoying the bliss of enlightened village community life under the leadership of the village *Panchayet*.

Once this fundamental necessity is recognised, the other points of importance in the matter of saving the cow will allow themselves to be readily developed in all their pleasant details.

CHAPTER X

GROWING AND CONSERVING FODDER —GRAZING.

414. Question of land for fodder solved : Granting that people will concentrate on securing the essentials of life through the corporate institution of village communities, it will be evident that a lot of the village lands, the produce of which is employed for securing the no-essentials of life, will be set free. Such soil will go towards the raising of suitable fodder-crops. The question, therefore, of want of land for growing fodder will not crop up. It is a fact that India exports a lot of her agricultural produce. In exchange for such agricultural produce India imports many essentials and non-essentials. The India of the future will cease to export things that are the products of agriculture and are necessary in India itself. On this hypothesis, India will cease to export cotton and cotton seed, wheat and millets and *mohua* etc. Sufficient will be grown to meet our internal demands, and something to carry over for emergencies in years of drought and crop failure. If this policy is adopted in the villages, if the villagers care to grow primarily that for which there is an internal demand, then no Government, alien or inimical to the interests of the people, can force such villages to grow this and that to

meet outside orders or in answer to the temptation of the high prices promised.

415. Stoppage of the export of agricultural produce : It may be asked, if the export of agricultural produce is stopped, how will India pay for her imports ? The answer is that India will cut her coat according to her cloth. She will adjust herself. She will import only as much as she can conveniently pay for by export of the surplus products of her soil. This surplus may be in the shape of minerals, live-stock and other manufactured goods. If there is a large gap in the imports, India will suffer that large gap to remain. A colossal quantity of the un-essentials that are imported now will cease to come. Thus shorn of her un-essential imports, India will stand on firm ground.

There is room, therefore, of curtailing or stopping the export of the products of agriculture, and for sowing on the land thus freed, plenty of fodders and food, and the other essentials of life.

Voelcker very strongly recommended the *stoppage* of the *export* of the productive power of the soil, in the shape of oil-seeds, oil-cakes and bone-manures.

This would certainly cease under an alert village community. Linseed is a large item of export. India will cease to grow linseed in excess of her internal need, and put part of the land under linseed to fodder. The same will apply to the growing of jute. Jute will cease to be grown for export purposes, in a raw or manufactured state. The manufacture of jute products in the Indian mills does not serve the

villagers. The jute-millers combine to force any price they like. The cultivators with wide-awake village communities will look with suspicion on all speculative articles in the market, the prices of which do not depend upon natural demand and supply, but are regulated by speculators situated in any quarter of the globe. The Indian cultivator will be disinclined to grow anything which he does not need for himself or for his neighbours.

416. Selection of fodders : If it is found possible to release a portion of the land from jute and cotton, from linseed and ground-nut, if it is decided to grow food and fodder in replacement, the question that will come next will be the selection of fodders for cultivation. Each Province and each group of villages will choose according to its particular needs. Less stress will be put upon the stalks of paddy and wheat as cattle food. These form the main roughage today. But some of them, and rice-straw in particular, are very deficient in the essentials of the feeding needs of the cattle. Supplementary fodders should be chosen to correct the deficiencies. Generally, legumes are of all-round utility. Legumes not only supply fodder but enrich the soil by nitrogen fixation. Legumes, if grown as pulse, serve a three-fold purpose—of feeding people, of feeding the cattle from stalks, and also of feeding the soil with nitrogen which it needs very much. This triple utility-crop should be pushed as far as possible as the second crop, because it rarely occupies the soil for more than six months. After the legumes are harvested, the soil is left richer for raising the next crop.

There are very many high-yielding grasses for every province and climate. A choice will have to be made of a group of them for particular areas. Guinea grass, Napier grass, Maize, Senja, and Anjan are familiar grasses having high yields, and some of them are particularly rich in digestible protein. In the Chapter on nutrition will be indicated the lines of choice for these grasses.

417. Conservation of fodder : Fodder has to be grown, and what is more, fodder has to be conserved. Stalks of cereals and the common legumes may be stored after drying. But not so the grasses. The grasses show their best growth during the rains. The cattle can be fed on them or allowed to graze. But the extra supply is difficult to conserve for future use during the dry season. During the rains it is difficult to make hay. Any chance shower will spoil the grass exposed for drying in the sun for making hay. In wet areas this is particularly difficult. When there is the utmost growth of succulent fodder, they have perforce to be wasted, for they cannot be dried and conserved. This has been so hitherto. But there is no reason why it should be so in the future, with an awakened and active village community life.

418. Excess of fodder preserved by ensilage : Ensilage is the process of preserving green fodders, for use as a moist succulent during the seasons when other fresh fodders are scarce. Preservation is done in 'silos' or pits, in stacks or towers. The green fodder is stacked and pressed so as to expel the air, and then sealed out of contact with the air. The sealing

prevents or delays the decay of the fodder. The purpose of putting in a pit or in a tower, of compression and of covering up, is all for the exclusion of the air. If it finds access the fodder gets heated or burns up and gets rotten and destroyed.

The stacking in an air-excluded atmosphere may be accomplished in various ways. The simplest way is to dig a pit, line it with brick and cement, and thus make it water-proof. But a cemented pit is unnecessary. Where the earth is hard, simple excavation will do. Silos are also made in silo towers. This a tower-like round well, is built above ground. The loading and unloading becomes difficult in such a case ; mechanical appliances for this purpose may have to be used. This is out of the question for our cultivators and breeders.

An excavated pit is the best for our purpose. The cost of excavation is practically nothing or very little, and the same pit may be used year after year. It is claimed that silage of most excellent quality can be made in pits.

419. Site for silo pit : The most essential point is that the bottom of the pit should be a few feet above the water level during the rains. If this is not assured, water will percolate from the sides and spoil the silage. The site, therefore, should be chosen with care, preferably on a mound, and with very good drainage. The site may be near the cow shed from where silage can be issued for consumption without great labour for haulage. For larger pits for big herds a site in the fields where the fodder is grown is usually chosen. The filling operation becomes

easy. For use, the silage has to be carted away to the byres. Occasionally, the finished material becomes sludgy on account of moisture in the fodder due to the time of ensilage. Such materials are difficult to be carted away for use.

In areas where the water-level rises every rainy season, flooding the country and fields, artificial mounds will have to be created. This is a difficulty particularly in very wet areas where they are most needed. For, in the deltaic areas, where annual inundation occurs, the peasants find it difficult to keep their dwelling houses sufficiently high above the flood-level. In such places, particularly high mounds may be created by the excavation of tanks in the fields by co-operative labour. It is again true that the conservation of fodder is also most wanted where the level of water goes up. In East Bengal, particularly during the months of rain, the whole landscape is a vast sheet of water with the houses of the inhabitants standing like little islands, each one separated from the other by sheets of water. The selection of sites for silos is a problem in such localities.

420. The silo pit : The pit may be of any shape, but a rectangular shape is preferable. The height and width are generally kept equal, say 8ft. ; the depth should not be less than 8 ft. The sides of the pit must be made smooth so that the exclusion of air may be easy and compression may not be interfered with. The length may be twice or three times the width or depth. The corners must be rounded off. A circular shape is most suitable for single pits.

It should be remembered that some fodder is lost in surfaces of contact with the earth and, therefore, very small pits are uneconomic. Large pits on the contrary take too long a time to fill or empty out.

The appropriate size may be calculated from the requirements of storage. A cubic foot will hold eighteen seers of green fodder at the time of filling. There will be shrinkage and lossage depending upon the moisture-content and state of maturity of the fodder at the time of filling.

Taking the shrinkage to be, say, one-third, one cubic foot packed will give 12 seers wet material at the time of feeding. On this basis a pit measuring 8 ft. deep \times 8 ft. wide \times 10 ft. long will give 640 cubic feet. If it is stacked on top in a slope it will hold one-third more.

Such a silo is expected to feed a unit of 10 heads of cattle for about $1\frac{1}{2}$ months, more or less, depending upon the size of the animals.

It is an advantage to have several pits, rather than one very large pit.

421. Filling the silo pit : The pit may preferably be sheltered with a light rain-proof structure at the time of filling, for if there is rain at the time of filling, it will spoil the silage. Two feet of materials may be put into the pit daily and well pressed in by walking and pressing. When the pit is entirely filled up, it is well to ram it down by men, and then allowing the bullocks to tread over and press the materials down. When an old pit is used, all decayed matters and sludge should be cleaned out, and the pit mended.

Grass and fodder may be put in, as received from the field without chopping. But then these will have to be cut out at the time of feeding by a special digging instrument, used, for instance, for digging wells in alluvial soil. The fodder really has to be cut out of the mass as there is no question of lifting it. Because by packing and ramming the mass gets felted or matted. If chopped fodder is put, discharging becomes an easy operation. The top should be heaped with fodder like the slanting roof of houses. An incline of 45 degrees is preferable. The slope is also to be rammed in and pressed down. Over this a six inch or one foot layer of ordinary dry leafy stuff or straw or stubbles has to be piled. The straw or stubble layer protects the silo from contact with the covering earth and, therefore, from being soiled. Half the volume of earth excavated out is to be utilised for covering ; this forms a heavy thick coat and is rain-proof. The sides of the pit should be sloped away to drain off the water. There should not be any surface drain near the pit, for such drains absorb water which percolates into the pit. The neat, beaten and rammed surface should be turfed so that there will be less chance of the top-covering earth being washed away.

A well-made silo will keep indefinitely, provided that water and air have no access to it. A silo has been found to be in an excellent condition even after 4 years of filling.

It is necessary to inspect the top covering, specially during the rains and after the rains. If there are

any subsidence, crack or washing out, these must be attended to and the covering kept in a state of repair.

422.. Opening the pit : One has to be particularly careful in opening the pit. Only a small opening is to be made at the commencement, and only that quantity that has to be used for the day may be taken out. The withdrawal should be gradually along the whole width, and in sections reaching down to the bottom. If two feet along the length is exposed, those two feet should be taken out down to the bottom layer. During the emptying operation also, care about the exclusion of air is to be taken as far as possible. It is, therefore, that the necessity of storing in a number of small pits arises, so that a pit once opened may be finished off quickly. During the emptying care should be taken to consume at least three inches depth of the exposed surface.

Soiled matter and sludge that may happen to be present on top or bottom or the sides, and water which may begin to percolate on opening, should be collected and used as manure.

During the emptying there should be a light roofing to protect the pit from the entrance of rain water into it.

If very succulent or immature stuff is ensilaged, it will be found to be thin, and water will ooze out at the time of emptying it. Such stuff the cattle do not like, and is also difficult to handle.

In order to avoid this, precaution should be taken at the time of filling. A mixture of dry stuff like hay or straw or stalks of wheat or *joar* has to be alternated

in filling. It is not necessary to mix the green and dry matter in filling. One layer of dry matter is to be laid, and over that a layer of green matter. The proportion of green to dry fodder should be regulated by the condition of the two materials. Alternation of layers with less succulent material, such as straw and mature maize-stalks also, will serve the purpose of taking up the moisture from the pure succulent material in a silo, and give the desirable character to it.

Government farms are now making ensilage. The nearest place where ensilage is done may be ascertained, and the presence of any enquirer at the time of filling and emptying may be arranged. Nothing helps as seeing the filling and emptying operations under local conditions. This may avoid much trouble and disappointment.

423. Conservation of dry fodder : Conservation of dry fodder is a simple matter and the different local practices indicate the way. Stacking is the usual method with a fence round to keep off the cattle. There is the inevitable wastage on account of exposure to sun and rain, and also deterioration in quality and digestibility. It is claimed for the silo that the loss in this method of storing is less than in dry stacking.

The following are the advantages claimed for ensilage :

1. It provides moist and succulent fodder in seasons when green fodders are scarce ;
2. It absorbs surplus green fodder in times of abundance ;

3. It saves all fodder in a palatable form and the loss both in preserving and feeding is less than with the dry fodder ;
4. It is more palatable than dry fodder ;
5. Being kept under earth it is thief-proof and fire-proof.

But there is one defect in ensilage. All cattle cannot be fed wholly on the silo. Its moisture-content being high, the working bullocks should have some dry fodder mixed with it. Dry and milking cows can, however, be maintained solely on the silo.

424. Grazing in village commons : There are certain areas in the villages shown in the Settlement records as belonging to the public. Slices of land for grazing, for cremation or burial grounds, are shown as public property. The public has unfettered rights to use them. But because of the greed for illegal possession, the grazing lands are in some areas being let out to tenants for cultivation, and in other cases gradually encroached upon. With a growing cattle population, the shortage of common pasture in the village is being more keenly felt. In fact, the areas are often so small compared with the cattle-population of the village that such grounds may be regarded more as standing and strolling grounds for exercise. There is not much material to graze upon at any time. The cattle being too many, there is a competition between grass-blades and the animals. So soon as a blade makes its appearance there is a living pair of scissors to bite it off. The cattle succeeds in the competition and the pasture remains bare.

Many suggestions have been made from time to time for the restoration of the common grounds encroached upon or let out, for the regulation of the excess of animals over the lands, for fencing these off and cultivating these for fodder or grass, and allowing the produce to be cut and distributed. But nothing practical has resulted. With the death of the village communities these public amenities of village life have



Fig. 32. Skin-and-bone animals—
the result of forest-grazing.

(Live-stock Problem vis-a-vis Grazing)

disappeared also. It has also been brought out that the expansion of the common village pastures will be of no use, for no sooner are the expansions made than they would be filled with reedy cattle without bringing about any but temporary improvement in the situation. It is no good crying over **spilt milk**. These common pasture grounds have disappeared for

good. The revival of village communities may revivify village life, and the proposition of extended common pastures will then be a living issue. Therefore today, beyond wishing the revival of the village communities, nothing in particular is to be thought of or done about these common pastures. Things have come to such a pass that even the droppings in the pasture are, in some places, guarded and removed by the



Fig. 33. Well-nourished animals—
the result of stall-feeding.

(Live-stock Problem vis-a-vis Grazing)

herd-boy as soon as he discovers that the dung is from one of his own cattle.

For all practical grazing purposes, these common pastures may be regarded to-day as fully lost. (596)

425. Preservation of pasturage: The flanks of the railway embankments, the river and canal banks, the road-sides are now used as pastures. The village

roads and paths are being encroached upon by the owners of adjoining fields. Nice wide roads will in places be found rendered narrow and almost impassable for traffic on account of these encroachments. Yet these road surfaces and flanks afford some pasture. But there is nothing to be done now. When the village communities are re-established, the newly created bodies will know their duty by the village commons, pastures, village roads and paths, and deal with them appropriately. (596)

426. Forest grazing : It is a vast and interesting subject. Only the outlines can be discussed here.

It was *Dr. Voelcker* who drew the pointed attention of the Government to the resources that are in these forests, and recommended ways and means for their better utilisation for the public. He argued that the forests were not there for providing revenues to the Government but for service to the public as far as possible, which was also the declared policy of the Government. He urged that the declared policy be given effect to. He pointed to the forest for providing (a) scope for better grazing, as also (b) for providing fuel which will go towards *releasing cow-dung* to be used as manure.

The aspect of forest as providing pasture will be taken up here.

STATISTICS OF FOREST GRAZING : There are 158 thousand square miles of land under the Forest Department in India. A very large area classified as uncultivated land is in the hands of the Revenue Department, and, therefore, this area

though large, has to be considered separately from the forest area.

Of the forest area the higher Himalayan forests are practically unused, and the great belt of the Himalayan forests in Bengal, Bihar and the U. P. along the foot-hills are also too far out of the reach of cultivators. (396, 596)

427. Provinces concerned with forest grazing :

The provinces concerned with forest grazing are mainly the United Provinces, Madras, the Punjab, the Central Provinces, Bihar, Bombay and Sind. The grazing facilities can be taken advantage of by a very small fraction of the whole live-stock population. Reserving consideration to the cattle alone, the figures are found as under :

TABLE—29

Number of cattle grazing in forests.

	Grazing.	Total cattle
United Provinces	1 million	32½ million
Madras	1½ „	24½ „
Punjab	1 „	16 „
Central Provinces	3 „	14 „
Bombay	2 „	10 „

Total ... 8½ millions out of 97 millions.

In the provinces where the cattle are most grazed, it appears that only 8½ per cent can take advantage of this facility. The all-India figure is much lower—it may come up to only about 5 per cent. (396, 596)

428. Figures for the five grazing provinces : Taking into consideration their entire live-stock population the figures are as given below :

TABLE—30

Provinces.	Total forest area in square miles.	Total forest area open to grazing. Sq. miles.	No. of live-stock in thousands utilising forest-grazing				No. per sq. mile opened & acres per head	
			Buff.	Cows, bullocks.	Sheep, goats.	others.	Total	No. Acres.
U. P.	6,000	4,000	146	883	250	10	1,289	322 2
Madras	16,000	14,000	108	1,370	732	—	2,210	158 4
Punjab	5,200	4,700	247	866	1,557	56	2,726	580 1.1
C. P.	19,400	17,000	312	2,500	300	5	3,117	183 3.5
Bombay	14,000	12,400	353	1,514	542	17	2,426	195 3.25
Total—	60,600	52,100	1,166	7,133	3,381	88	11,768	226 2.8 (average)

The 1935 census figures for the total live-stock population in thousands :

U. P. (excluding Kumaon)	...	9,293	23,177	10,002	818	43,290
Madras	...	6,817	17,790	18,700	203	43,510
Punjab	...	6,048	9,792	8,589	1,398	25,827
C. P.	...	2,194	11,650	2,193	185	16,222
Bombay	...	2,513	7,448	3,790	200	13,951
Total—		26,865	69,857	43,274	2,804	1,42,800
Rest of British India	...	4,768	42,147	15,111	539	62,565
Indian States 66%	...	12,351	42,022	33,752	1,790	89,915
Total All-India.	...	43,984	1,54,026	92,137	5,133	2,95,280

—(396, 596)

429. Area of incidence per head of cattle : From these figures the proportion of incidence per acre cannot be gauged. Here statistics fail. The incidence, according to statistics, apparently (*vide* Table 30) varies from 1·1 acre per head of cattle in the Punjab to 4 acres per head in Madras, the total average being 2·8 acres. But the areas are total areas, including dense, impenetrable and ungrazable forests and also high altitudes, where very little grazing is either available or can be taken advantage of, being inaccessibly remote from all cultivation and habitation.

The real incidence per head on the fringes of the forest lands near villages, round sources of water supply and where temporary camps may be set up, must be quite high, proving extreme overstocking. (396, 596)

430. Token-fee for grazing : Grazing is practically free in the Punjab, where the villagers enjoy the right of grazing cattle. In the United Provinces 68 per cent of the cattle, utilizing grazing, are allowed to do so free as an admitted right. Everywhere when the animals have to pay fees, the fee is only nominal being as under :

Animal	per annum.
Cows, Bullocks & Bulls—	2 to 8 annas
Buffaloes—	... 12 annas to Rs. 2/-
Calves—	Free
Sheep and goat—	$\frac{3}{4}$ anna to 2 annas.

This token-fee for permission allows the owner to graze their animals over large areas. The number of

animals on grazing areas is too much, any number being admitted, and the nominal fee is no bar to keep a large number of animals in villages near forests or in forest camps. The small fees received create no inducement in the Forest Departments to improve the grazing areas ; on the other hand, it creates irritation in the fee-payers that the fee is taken, but nothing is done for them to better the grazing conditions. The present conditions are such that these grazing areas might be utilised and are often utilised, as sites for fuel manufacture. An unlimited number of cattle on the payment of a nominal fee is allowed to graze and multiply. Their dungs are dried and brought down for use as fuel. A shockingly perverted use of animals ! Of course ! The poor cattle, however poor they be in their bodies, bring some value also when they are sold.

Things could be much improved. It is not that improvements are nowhere being made. On the contrary, in the U. P., the C. P., Bombay and Madras, the Forest Departments are keen on improving conditions. But as things are, very little can be expected. The forest grazing problem, taken by itself, has not much scope for improvement. It was suggested that only a limited number of cattle be permitted in specified areas, that the areas be controlled by closures, and that graded fees be taken for animals, according to their economic value—the more degraded and the useless stock having to pay more, and the superior cattle only nominal fees. This last suggestion is unpractical, for the line between good and bad

cattle is thin. The C. P. is applying control and also applying closures to certain areas. Madras and Bombay are also introducing it in some tracts. Only a beginning has been made. But where there is enthusiasm some rapid result may be expected.

The Royal Commission recommended also the encouragement of grass-cutting in place of grazing. This has also been found to be impracticable. Cutting is a much more expensive process than grazing. There is the problem of drying and pressing the grass and of transport for areas situated at a distance, cattle wherefrom cannot directly come to graze. At the period of grass cutting, labour is most difficult to obtain, men being engaged in other field-work. These difficulties have been found to be insurmountable. With all these facts, not much may be got out of forest grazing for the present, beyond what is already being done. (396, 596)

431. Forest grazing in Bengal : A brief enumeration of the position of forest grazing in the provinces is attempted below. In the inhabited region of the Himalayas falling within Bengal attempts were made by the Government to encourage stall-feeding. This seems to be mainly a measure for improving the milk-supply of the hill stations. A system was introduced of building cattle-sheds at Government cost and of charging a small fee for cutting grass for stall-feeding. The Government, it appears, went faster than it was safe. These-cattle sheds were used to encourage milk-supply from cross-breds. These in the colder atmosphere of the Himalayas undoubtedly gave milk,

but failed in draught-quality. The male progeny were of little use to the cultivators for draught. These attempts were restricted to the Darjeeling and Kurseong forests. The Kalimpong Forest Division, however, could not attract tenants of cattle-sheds for stall-feeding. The scope of work in these cattle-sheds for stall-feeding experiments was naturally very limited, and has no bearing on the general cattle problem of the Province.

The Dooars are also hill tracts. These are, however, very sparsely populated by the hill people, and the plains villages are too remote to take advantage of the Dooars foot-hills for grazing. In the Chittagong Hills and in the Hill Tracts Division cultivation by hill people is of the shifting method. Grazing is permitted, but its economic value to the Province is insignificant. (396, 596)

432. Forest-grazing in Bihar : In Bihar the problem loses much of its significance because only 3% of the area is under forest. Apart from this, the Government possess an insignificant portion of the total grazing area of the Province ; the total area owned by it in Bihar being 2·2 million acres as against 40·5 million acres held by private owners.

Of the Government-held area, the true forest area needs little doing. It is in the derelict and ravine land that there is room for improvement for grazing. It has been suggested that if such areas be trenched and protected from cattle, then these may be soon converted into grass lands on which grass-cutting or rotational and controlled grazing will be possible.

There is much waste land in private possession as also forests. These are not properly managed. If they were managed properly a lot of grazing could be arranged for. (396, 596)

433. Forest-grazing in Bombay : Much work has been done by the Agricultural Department, particularly in the dry tracts. These measures have proved that a great deal of improvement in providing for grazing or growing grass can be achieved by fencing, by rotational grazing, by limiting the number of cattle, by prevention of grazing during monsoons, by providing facilities for obtaining water and providing shade trees.

Forest-grazing is developing under planned management in which 500 acres are divided into five 100-acre units, and one 100-acre unit remains closed to grazing every 5 years. Besides this, 36,000 acres are allotted to grazing before cutting every year. In the dry tracts of Bombay over-grazing is doing a good deal of harm. (396, 596)

434. Forest-grazing in C.P. & Berar : Government forests represent about 1/5th of the total area of the Province. About 86 per cent of these forests is open to grazing. Besides this, there are large areas of private forests in it. Planned work is conducted by the Forest Department, and periodical and rotational closures are applied.

The condition of the C. P. cattle generally in connection with the problem of *forest grazing* was brought out by Mr. C. M. Harlow, Conservator of Forests, Western Circle C. P. in his note for the 2nd A. H. Wing meeting.

"It is a general fact, usually true but with few exceptions, that the more grazing facilities, the worse the cattle, and it is invariably true that few good cattle resort to the reserved forests for grazing. The more intelligent section of the community occupy the better land, usually far away from the forests and the lands near the forest are poorer in quality and in the hands of aborigines or other less intelligent castes. The cultivator of the plains keeps no more cattle than he needs ; each one is of great importance to him, he cares for them and feeds them fairly well. When he has to replace them, he may buy from good breeds if available, but more generally from selected cattle brought to annual fairs from the more jungly neighbourhoods. These cattle improve somewhat by more regular feeding. The inhabitants of jungly areas keep large herds of miserable cattle, far larger than they need or the country needs. For practical purposes they never have any stall-feeding. When the crops have been reaped they graze in the fields. At other times they graze in the forest or in the village grazing lands, going daily to and from the forest."—(P. 216). (396, 596)

435. Forest-grazing in Madras : In Madras the forests are interspersed to an extent with villages so that grazing from near-by villages is a distinct feature. The fringes of the reserves and forests are overgrazed. There have been experiments with better varieties of grasses. But these cannot pay unless

grazing fees are raised. This is the opinion of the Forest Department. Grazing-fees vary from three annas to one rupee per cow for the whole year, and the average is eight annas.

Attention is paid by the Forest Department to keep the grazing grounds clear of prickly pear by cochineal insects. Some attention has also been paid to the question of supply of water in grazing grounds.

Some rotational grazing is done in a few places of which the Kancha System is worthy of mention. Nellore is the only area in the Presidency in which grazing is managed on sound principles. This system is a time-honoured one and has worked satisfactorily so far as the owners of superior cattle are concerned.

Under the Kancha System grazing areas are divided into grazing blocks which are leased out at a definite rate per acre. The Kanchadar or lessee is bound by the terms of his agreement to protect the area, close it to grazing for three months during the monsoon, and to limit the admission of cattle to a maximum. (396, 596)

436. Forest-grazing in the U. P. : In the United Provinces large herds of cattle are frequently grazed in fringes of savannahs and forests for the purpose of manure and fuel which is required in unlimited quantities ; and the number of cattle grazing in these is also unlimited. With all that, however, only a small percentage of the cattle can have access to the forests on account of their location. Out of the 43½ million domestic animals, 42 millions do not visit

the forests. Of the forest-area which this $1\frac{1}{2}$ million animals visit, 68 per cent are free by right or long-standing concession, and, therefore, no limit to them can be put. In spite of all that the forest-areas are improving on account of managed grazing and sound sylviculture.

As in Bihar so in the U. P. the real problem is the better utilisation of derelict and waste lands in Government hands and in private possession. (396, 596)

437. Forest-grazing in the Punjab : In the Punjab forest-grazing is a sore spot in the management of forests. The forest officers of the Province have been realising for many years past that rapid and wide-spread deterioration was taking place in almost all the foot-hill forests on account of over-grazing. As the forest-areas are practically wholly open to grazing by right or tradition, it is not possible to regulate it. And the mischief is continuing, causing erosion, and denuding the slopes of grass and vegetation. It is a growing evil; and some arrangement with the foot-hill people is necessary for restriction on grazing in their own interests. (396, 596)

438. The rest of the provinces : The condition of the N. W. F Province is also very nearly the same as that of the Punjab.

In Assam, Orissa and Sind there is no grazing problem as the need is small, and the forest areas are relatively of small importance. Only 3 per cent of the total cattle-population utilise grazing, and there is plenty of grazing available for this number.

amounting to 45,000 horned cattle who are sent to graze. (396, 596)

439. Grazing outside Government forests : Vast areas of land under the Revenue Department and in private possession are wastes, parts of which may be profitably utilised for growing grasses for fodder. Very material improvements are possible in these lands. Unlike many forests, these waste lands are interspersed in between habitations, and it is, therefore, that their reclamation for use for grazing is likely to be most beneficial. An example is supplied by the U. P.

In the Province there are very large areas of waste land, known as *usar*. These are alkali soils. It is a commercial proposition to utilise these as natural sources of alkali or sodium carbonate. During the last Great War an attempt was made and successful experiments were carried out for the manufacture of alkali from '*reh*' soil or *usar* soil. The alkali is on the superficial half or three-fourth inch of the surface. If this is scraped off, the next year another similar layer of alkali is obtainable. Thus, it could be used as a source of supply of alkali for some time at least. The experimental work was discontinued probably owing to the cheapness of the imported stuff after the war. (396, 596)

440. Reclamation of *usar* soil : But the soil is there all the time a waste, and waiting for reclamation. Numerous experiments were conducted for draining the alkali out of the soil. Many theories were advanced for the presence of the alkali in these lands,

and the principle underlying their accumulation and re-formation. But it is only recently that the U. P. Government seems to have caught upon a very simple process of reclaiming them. The lands are so alkaline that no trees can grow on them. But where trees fail, grass can grow, and it can grow only if it is protected from grazing. This was tried. *Usar* lands were closed to grazing. The blades of grass that grew thrived and covered the soil more and more with a green mantle. The grass was allowed to be cut. This experiment has been a remarkable success. Below is a record of 4 years after applying closure to grazing.

Year.	Yield of grass per acre.		
1931	2·7 maunds
1932	4·8 „
1933	9·3 „
1934	12·1 „

By four years' endeavour the grass-yield had gone up from 2·7 to 12·1 maunds per acre. In some *usar* areas near Unao and Cawnpore, which have been protected for a long time from grazing, yields of over 29 maunds of hay per acre have been attained.

These experiments suggest that the fodder problem of the U. P. can be very materially solved by the utilisation of the *usar* lands for hay-making.

441. Utilisation of canal banks and poor land :
 "For the production of timber, fuel, and fodder, these have proved unequalled, and the canal plantations show a rate of growth that cannot be surpassed by

any forest areas in the Province." (Smythies. *2nd meeting A. H. Wing*, (1936).—P. 230). This matter will be referred to again in connection with tree fodders.

There is also a class of land which is precarious for agriculture on account of the poor quality of the soil. These can be converted into grass plots during the monsoons and the grass cut and silaged. Some method of closure is to be applied in order to let the grass grow. After cutting and hay-making, such lands may be opened to grazing for the supply of manure to the soil for its gradual but permanent improvement.

442. The tree-fodders: There are a variety of of trees the leaves of which may do for supplying fodder, and their lopped-off branches for supplying fuel. After a time, by rotational planning, the trees may be utilised for fuel or timber, and replaced by a newer ones for continuous supply of fodder.

Regarding the possibilities of tree-fodder Mr. Smythies, Conservator of Forests, Western Circle, U. P., writes :

"...In the dry and inferior type of grazing areas, it is a mistake to think only in terms of grass. One of the most important developments in Forest Department in recent years has been the realisation that fodder supplies in dry tracts can often be greatly improved and increased by making plantations of fodder-trees. It is obvious that a fodder-tree, which stands annual or periodical lopping, produces a much greater quantity of leaf-fodder than the grass that would be produced on the ground it occupies. The Forest Department

is very actively following the policy of creating extensive plantations at negligible cost by means of *taungya* for the improvement of fodder supplies, as well as improvement of timber and fire-wood. I would instance the Shahrampur division, where over 2,000 acres of successful plantation have already been started and where we aim to take up 600 acres per annum for the next 50 years. Also, the Bhinga forest of Bahraich, where over 20,000 acres have been set aside for *taungya* plantations, and to improve *inter alia*, the facilities for grazing and leaf-fodder for the surrounding villages. Our *taungya* villages in Shahrampur have already a population of over 2,000 and we have started village schools, medical attendance, co-operative societies, etc. These facts will indicate how important we regard the organisation for creating successful *fodder and fuel plantations*. We have no hesitation in thinking that this line of approach holds out greater promise than any possibilities of improving the grass, as these dry areas are by nature intended for tree crops, rather than for grass production, and the production of leaf-fodder in three dimensional space must obviously be far greater than any possible production of fodder grass in two dimensional space. Our plantations are not yet old enough to stand lopping (the oldest are only 5 years old), but we propose in due course to have controlled rotational lopping of leaf-fodder, and the details will be worked out as we gain experience."

“Lopping for leaf-fodder in existing forests : This habit is wide-spread and forms an important addition to grazing in the feeding of live-stock. Experience has proved conclusively that control of lopping is essential. For example, the *gujars*—notoriously destructive loppers—lop widely in the forests of the Western Circle, but under control, and no lasting damage to forest results....” (Smythies. *2nd meeting A. H. Wing, (1937).*—P. 229)

That the trees, properly lopped by rotation under control, can supply a large bulk of fodder has not been sufficiently taken advantage of. There is wide scope of expanding this source of fodder-supply. Waste lands and canal banks situated when they are within reach of the villagers may be extensively used as sources of both fuel and fodder on plantation of suitable trees. The *babul* (acacia) will grow in some of the worst soils. The people of Sind have found it indispensable as a source of fodder from the leaves, concentrates from the seeds, and of fuel and timber from the trunk. The heart-wood of the *babul* goes to make cart-wheel and cart-axles. I may add that the *babul* bark is a very valuable tanning material also. It grows in soils which will not grow any valuable plants and will go a great way towards solving the village needs of fodder and fuel. The idea is nothing new.

443. A chapter of lost opportunities : ‘*Fuel and fodder reserves*’ was the one cry of Dr. Voelcker. Below, he is quoted rather in *extenso*. It is to show how extensively could the fodder and fuel question

have been solved if the very useful and practical course of creating fuel and fodder reserves had been taken up, and pursued without break. The examples cited by Dr. Voelcker are living sources of inspiration about what even now can be done in solving the fodder problem. The Railways and the Canal Embankments, the banks of small streams, the waste lands, the *usars*, all can contribute to forming a living and plentiful supply of fuel and fodder.

444. Fuel and fodder reserves, plea of Voelcker : Dr. Voelcker wrote in his Report :

“...the way in which the supply of wood to agriculture can be best increased is by the *creation* of new enclosures of land for the purpose of growing wood, scrub, jungle, and grass. Such enclosures are now denominated ‘Fuel and Fodder Reserves’.”

“The establishment of ‘Fuel and Fodder Reserves’ was advocated successively by Sir D. Brandis in 1873, by the Famine Commission in 1879, and by the Government of India in 1883, acting upon the recommendations of the Famine Commission.”

—(P. 152)

“The earliest ‘Fuel and Fodder Reserve’ in the strict sense, that I can find mentioned is the Patri forest, near Rurki, North-West Provinces. This plantation was begun in 1871, five blocks, comprising in all 80 acres, being demarcated, and trees, mostly *sissu* being planted and watered by a cut taken off from the Ganges canal...This practically was of the nature of a ‘village forest,’ and was agricultural in intent.

"The forests of Ajmere-Merwara, although of large extent and under the Forest Administration, are really 'Fuel and Fodder Reserves' on a large scale.As I have said they more nearly approach my idea of what 'agricultural forests' should be than anything else which I have seen or read of under the Forest Administration. My complaint is that there are *not enough* Ajmere-Merwaras. ..." —(P. 153). (28, 31, 411, 445-'53, 462, 577)

445. Tree-planting in Etawah, Jhansi, Cawnpore :

"Etawah, Jhansi, Cawnpore, and Awa are the chief places where tree-planting has been tried to any considerable extent, for on the *usar* land at Aligarh, it has only been done on quite a small scale, and the efforts have been confined mainly to grass and crop-growing..."

Speaking of the success in Etawah, he observed : "About 4,400 acres (7,000 *bighas*) of this land belonged to the native land-owners (*zemindars*), and the area was of but little use except for cattle to roam over. In 1885 the Agricultural Department of the North-West Provinces persuaded the *zemindars* to let it try the experiment of tree-growing, and got them to advance Rs 600/- for planting *babul* seed over the land. Cattle were kept off, *babul* seeds were scattered broadcast just before the rains came, the trees came up capitally, the grass grew well, and soon, without any artificial irrigation, a useful 'fuel and fodder reserve' was formed out of what

had been simply waste-land. The 'reserve' now brings in an annual income of Rs. 1,100/- ... "

—(P. 155). (444, 577)

446. Classes of land available for Reserves :

"... I may here name the classes of land which might be available.

"(a) The waste land belonging to Government whenever a *raiayatwari* settlement exists, and including (in the case of Madras, at least) the sides of road-ways, channels, tanks, embankments (*bunds*), beds of streams &c.

(b) The waste land of villages (at least when in excess of village requirements) and other uncultivated areas.

(c) Salt plains and salt patches (*usar*) land.

(d) Ravine land.

(e) The banks of canals and railway lines.

(f) Land at present under dry cultivation, but which it might pay better to convert into 'reserves'."—(P. 157). (444, 577)

447. Reserves : Government waste land : "(a) In Madras the waste land all belongs to Government. Mr. Nicholson reported in 1887 that in the Anantapur district alone there were 1,141,089 acres of Government waste land and that there were parts where blocks of 1,000 acres could be dug round, enclosed with *banks*, and then seeds of trees be sown before the rains."—(*Ibid*)

"In his 'Manual of Coimbatore' Mr. Nicholson mentions places, such as Karur, Dharapuram, Kugalur, Palavapalaiyam, Nambiyur, Udamalpet,

and else where, where fuel reserves are needed and might be established. Of Karur he says :—"the channel and river banks might be planted with advantage...the *taluk* is poorly wooded.....even the most favourable positions, such as channel banks, deep spots near water, &c. are not utilised...there is one private jungle, but this is left to nature and not assisted by plantation...it produces *babul* trees and grass abundantly'."—(P. 157-'58)

"I noticed myself, when travelling in the Madras Presidency, many channel banks, sides of tanks and road-ways, where trees might have been planted.

"When enquiry was made in the Madras Presidency in 1883, it was found that, taking the whole Presidency, 100 acres of land to every village in a *taluk* were available for 'fuel and fodder reserves'.

"In the Central Provinces, in one *tehsil* alone of the Sambalpur district, waste areas of over 6,000 acres were found, which had remained the property of Government, and thus were available for conversion into 'fuel and fodder reserves'." —(P. 158). (444, 577)

448: Reserves : village waste and uncultivated areas : "(b) It is a question how far it is advisable to take up waste belonging to a village, but in the Punjab and in the Central Provinces, the latter principally, there are village lands which are considerably in excess of the people's requirements. The Lieutenant-Governor of the Punjab concurs in

thinking that land in excess might be turned into 'reserves'. Between Lahore and Amritsar I noticed uncultivated areas in abundance, and wherever trees occurred, they grew very well.

"Between Agra and Gwalior I saw a lot of uncultivated land.

"In Bengal, Mr. Finucane found that there were some $37\frac{1}{2}$ square miles in the Rhotas and Rehul plateaus of the Khymore Hills which might become 'fuel and fodder reserves'. The Bengal Government further authorised the purchase of 1,200 *bighas* of land belonging to the Deo Estate, and in Sasseram other areas were proposed. The Deputy Conservator, in reporting on them, said :—'I do not think any site could have been selected more suitable for the formation of fuel and fodder reserves'. The financial prospects, derivable solely from annual licenses granted to villages, were stated to be very promising.

"Between Bettiah (Behar) and the Nepaul frontier are strips which might be 'fuel and fodder reserves.' This land belongs to *zemindars*, and would have to be obtained by purchase.

"Also, near Segowlie (Behar) is a good deal of waste-land, it having fallen out of cultivation during the famine of 1865.

"The report of the Bombay Agricultural Department for 1886-'87 speaks of much land both in river-side villages and others eminently fitted for '*babul* reserves', and the Bombay Government has given remission of three-quarters of the assessment to

applicants willing to devote land to the extension of *babul* plantations, or to take up new land for it. "Such villages are some near Ahmedabad, Nasick and Poona.

"In Mysore I observed large stretches of land between the towns of Mysore and Hunsur which were not cultivated, but on which large amounts of fire-wood might be grown. In the centre of Mysore, near Arsikeri and Hassan, are large tracts that might be enclosed and made into 'fuel and fodder reserves'."—(*Ibid*). (444, 577)

449. Reserve usar land : "(c) The vast range of salty (*usar*) plains and patches in the North-West Provinces has been mentioned. Others occur in the Punjab, the Deccan, the Southern Mahratta country, parts of Madras, and elsewhere. Between Delhi and Rewari is salty land on which tamarisk bush grows well.

"(d) The ravines along both banks of the Ganges and Jumna rivers have been referred to."—(*Ibid*)

"Sir Edward Buck, in a note on the Muttra Settlement, speaks of the feasibility of introducing 'fuel and fodder reserves' along the Jumna Valley tracts, and points out that the experiments made at Ajmere and elsewhere 'prove that under proper management large areas will be available for trees and grazing which are not susceptible to ordinary cultivation'."—(P. 158-'59)

"Ravine land occurs largely at Pahara, near Mirzapur, North-West Provinces."—(P. 159). (444, 577)

450. Reserves : canal banks : railway embankments : “(e) The Administration Reports of the Central Provinces speak of there being always areas for brushwood on banks, beds of streams, &c.

“The Bombay Agriculture Department Report for 1888-89 regrets the great opportunity which was lost in not securing stretches between Hubli and Gadag, along the Southern Mahratta Railway, and on which *babul* grows splendidly.

“The Bengal Agricultural Department Report for 1889-90 says that it had been ascertained that along the Assam-Bihar, the Tirhoot extension and the new Chittagong-Assam lines ‘fuel and fodder reserves’ could be made.”—(*Ibid*). (444, 577)

451. Utilisation of dry land : “(f) It is quite certain that there are many stretches of dry cultivation, where crops are taken only occasionally, it may be once in three or four, or even once only in six years, but which could be much better utilised by turning them into ‘fuel and fodder reserves’.

“About 1,400 acres of such land exists at Mahim (Bombay), and is not worth one anna an acre for rent.

“At Avenashi (Combatore) is also a lot of dry land, assessed at one rupee per acre, which might grow trees well. This is also the case in Cuddapah.

“In parts of the Deccan, where wood for implements is very scarce, the growing of wood, even if not directly remunerative, would be a great boon to the cultivators.

"Mr. Fuller thinks that in the Central Provinces it would be good if Government were prepared to remit the revenue of a few fields in certain villages, on condition that the proprietors planted and maintained trees on roads running through it.

"I might here refer to an experiment now being carried out by Mr. Ozanne, at the Bhadgaon Experimental Farm of the Bombay Government. In June 1888 Mr. Ozanne sowed eight acres of cultivated land with *babul* seeds put in furrows; one-half of the area has had no artificial watering whatever, the other half only one watering, viz., in the first year. The interspaces between the rows have been sown with crops of *bajra*, gram etc. At the time of my visit, in August 1890, the plantation was growing well, some of the best plants were 4 feet high, and the plantation had cost nothing whatever, the crops grown between the rows having paid all the expenses."—(*Ibid*). (444, 577)

452. Plenty of land for fuel fodder reserve: "It is very clear, from the instances I have given, that there is a good deal of land on which 'fuel and fodder reserves' might be formed, and if only systematic enquiry be made it will result in showing.....that there is very much more land available than has been stated.

"In almost every district there are uncultivated spots---which would grow *babul* or similar wood perfectly well. Although it may not pay

Government to take up these plots, yet, if the example of tree-growing were set, encouragement would be given to native proprietors (*zemindars*) and others to adopt the plan also."—(*Ibid*)

Half a century has passed since these paragraphs were written. There have been many changes. The old names of provinces have given place to new. But the report so far as this matter is concerned remains. It appears that from before the arrival of Dr. Voelcker, because of the Famine Commission Report, an atmosphere was created for the utilisation of the fodder resources of India and also for the increase of the yield of food-crops by the supply of more manure. This was quite natural. Into this field came Dr. Voelcker and with his insight found out many more things than were apparent, and formulated a policy for the Government for securing more manure and more fodder by the supply of fuel and the growing of fodder. It seems, however, that the Government, after a while, lapsed into forgetfulness; this prime need for the population of India was neglected. Little can be traced today of what remains of the endeavours of the Government in the days of Dr. Voelcker's visit. What he wrote has to be searched out from his report or has to be re-discovered. (447, 577)

453. Voelcker's recommendations remain neglected: At that time Dr. Voelcker visualised that the Government at all cost should provide for manure and fuel, and pointed out ways and means. The Government has done very little, and the 1927 Royal Commission also has not shown any practicable way

out of the gradually-increasing degeneration of the cattle and therefore of men. (31, 444, 577)

454. Village communities may do this work : The necessity of creating village communities has been established. It would be for the village communities of the future to pull the resources of the waste-land in the country and convert them into fuel and fodder reserves. What the Government has not done, the people can do in so far as the lands are in the possession of private owners.

455. List of fodder-trees : The subject of looking up to the trees for fodder came up for discussion in one of the Animal Husbandry Wing meetings (*3rd meeting*.—P. 258), and a list has been published of the names of trees that may be used as a source of fodder, —famine fodder. But our idea is to look upon the trees as normal sources of fodder, to make up for the deficiency of fodder-supply.

Botanical name.	English or Vernacular name.	Geographical distribution.
<i>Acacia arabica</i> . *	Babul, kikar	Sind, & N. Deccan ; cultivated elsewhere.
<i>Acacia modesta</i> .	Phulai	N. W. India to Afghanistan.
<i>Aegle Marmelos</i> . *	Bael	All over India.
<i>Albizzia Lebbeck</i> .	Siris	„
<i>Albizzia odoratissima</i>.	...	„
<i>Albizzia stipulata</i>.	...	„
<i>Adina cordifolia</i> . *	Hardu	N. W. India & Afghanistan.
<i>Anogeisus latifolia</i>.	...	All over India.

Botanical name.	English or Vernacular name.	Geographical distribution.
<i>Artocarpus integrifolia</i> .	Jack tree	Wild in the Deccan ; cultivated in various parts of India.
<i>Azadirachta indica</i> .	Neem	"
<i>Balanites</i> .	Hingot	Hotter parts of India.
<i>Bauhina purpurea</i> .	Kanchan	All over India.
<i>Bauhinia malabarica</i>.	...	"
<i>Bauhinia race mosa</i>.	...	"
<i>Bauhinia variegata</i> . *	Kachnar	"
<i>Briedelia montana</i>.	...	N. India from the Punjab to Bhutan, also Coromandel.
<i>Briedelia retusa</i>.	...	Hotter parts of India.
<i>Buchanania latifolia</i>.	...	"
<i>Carallia integerrima</i>.	...	"
<i>Careya arborea</i> .	Kumbi	"
<i>Cassia Fistula</i> .	Amaltas	All over India.
<i>Coltris tetranda</i>.	...	"
<i>Cordia latifolia</i>.	...	Hotter parts of India.
<i>Delbergia Sissoo</i> . *	Sissoo or Shisham	Sub-Himalayan tracts, extensively cultivated.
<i>Diespyres montana</i>.	...	Tropical India,
<i>Ehretia laevis</i> .	Chamror	N. tropical and sub-tropical India.
<i>Ficus bengalensis</i> .	Banyan, Bar or Bargat	N. and C. India ; often planted.
<i>Ficus glomerata</i> .	Gular	Tropical India.
<i>Ficus infectoria</i> .	Pilkhan	N. India & C. India ; often planted.
<i>Ficus religiosa</i> . *	Pipal	All over India.

Botanical name.	English or Vernacular name.	Geographical distribution.
<i>Ficus Rox burghii</i>.	...	N. India.
<i>Ficus Rumphii</i>.	...	N. & C. India.
<i>Gmelina arborea</i>.	...	All over India.
<i>Grewia asiatica</i> .	Phalsa	N. & Central India.
<i>Grewia tiliaefolia</i>.	...	All over India.
<i>Grewia</i> <i>opposite folia</i> . *	Pastawuna	All over India.
<i>Hardwickia binata</i> .	Anjan (C.P.)	C. P.
<i>Heterophragma</i> <i>Roxburghii</i>.	...	C. I. & W. Deccan.
<i>Hymenodcityon</i> <i>excelsum</i>.	...	Sub-Himalayan tract. Deccan, C. India.
<i>Melia azaderach</i> .	Persian lilac	All over India.
<i>Melia azadirachta</i> . *	Neem	,,
<i>Morinda tinctoria</i> .	Al	,,
<i>Moringa</i> <i>pterygosperma</i> .	Horse-raddish	Wild in N. India.
<i>Morus indica</i> .	Tut Bengal	N. India..
<i>Morus Alba</i> . *	Mulberry	N. W. Himalaya.
<i>Morus serrata</i>.	...	,,
<i>Odina Wodier</i>.	...	Hotter parts of India.
<i>Ougeinia</i> <i>dalbergioides</i>.	...	N. N. and C. India.
<i>Petrocarpus marsupium</i>.		...
<i>Piptadenia oudhensis</i>.	...	Oudh
<i>Populus nigra</i> .	Lombardy Poplar	Cultivated in Punjab & N. W. Himalaya.
<i>Premna integrifolia</i>.	...	Bengal, S. India.
<i>Prosopis spicigera</i> .	Jhand	N. W. India.
<i>Quercus incana</i> .	Ban	Central Himalaya.

Botanical name.	English or Vernacular name.	Geographical distribution.
<i>Saccopetalum tomentosum.</i>	...	Oudh, Terai, Bihar, Orissa to Travancore.
<i>Salix acmophylla.</i>	...	N. W. India.
<i>Salvadora oleoides</i>		Plains of the Punjab,
Dene.	Jal	Sind.
<i>Schleichera trijuga.</i>	Kosum	N. India.
<i>Tecoma undulata.</i>	...	Plains of N. & W. India.
<i>Terminalia Arjuna.</i>	Arjun	All over India.
<i>Terminalia belerica.</i>	Bahera	Plains and lower hills of India.
<i>Terminalia Chebula.</i>	Harar	N. C. India.
<i>Terminalia tomentosa.</i>	Sain	N. W. N. & C. India.
<i>Wendlandia exserta.</i>	...	Dry forests of tropical Himalaya, C. India.
<i>Ziziphus ujuba.</i> *	Ber	All over India.

456. Flood fodder trees : Orissa is often under destructive floods. An enquiry was made by the Government of Orissa for information on tree fodders that could withstand flooding. The sylviculturist of the Forest Research Institute, Dehra Dun, in his note in reply submitted a list of trees for fodder, the leaves of which may be fed to cattle at times of scarcity of fodders caused by floods. He remarked :

"...One great difficulty with most of the trees which are lopped by professional graziers in the North of India is that the time when fresh leaf fodder is most abundant is also the time when generally there is little shortage of grass or other fodder. In the

particular case of floods this difficulty does not arise to the same extent, since the floods generally occur during the monsoon when fodder leaf production is also at approximately its maximum. It is permissible, therefore, in such conditions to include deciduous trees for growing for the particular purpose of relieving shortage of fodder caused by floods.

"It is emphasised that it is not likely that plantations can be raised successfully in areas where annual or frequent flooding is experienced, as it is unlikely that tree-seedlings will stand complete submergence when very small. If the water is moving, there is also danger of the seed or the young seedlings being washed out of the ground. Plantations should, therefore, preferably be made on village high lands where possible. In areas where occasional shallow flooding by water which is not moving appreciably occurs, the trees may be raised by sowing on mounds or ridges, but this is necessarily expensive. Certain species, such as *Ficus religiosa*, *Ficus bengalensis*, *Ficus glomerata* could be raised in such areas using large branch-cutting.

"All good fodder trees are readily browsed by wild animals and it is almost a *sin qua non* that browsing by wild animals or domestic animals be completely excluded during the early years of fodder-leaf plantations. Generally, fencing is the only satisfactory solution, but this is very expensive It is sometimes possible to establish fodder-trees by growing them along with a faster-growing thorny or unpalatable species which will protect

them during their tender years. As soon as the fodder trees are big enough the thorny nurse-trees are cut out. For instance, Nim (*Azadirachta indica*) can be sometimes raised successfully by sowing babul (*Acacia arabica*) or Khair (*Acacia catechu*) or *cassia siamea* along with it.

"Certain species which grow very rapidly can also be raised without protection from browsing by wild animals if they are sown very densely and if they grow very vigorously. Mulberry (*Morus alba*) is an example of a species which can sometimes be raised in this manner"

"...a large percentage of fodder lopped is invariably left untouched by the animals which, while still hungry, will turn from a good fodder species and eat leaves of other species not generally considered good fodder. The reason for this is not fully understood, unless it be that the leaves must be absolutely fresh when fed to the animals. ..."

—(3rd meeting A. H. Wing, (1939).—(P. 252)

Now follows the list of fodder-trees. It is meant for areas subjected to periodic floods. The whole of Northern India, one part or another, falls within the category—Orissa, Bengal, parts of Bihar and also parts of the U.P. The list, therefore, will be of use to many. Besides, on soils not flooded, they will certainly grow and serve the purpose, as a source of fodder.

457. Description of some fodder trees : *Acacia arabica* : Easy to raise. Grows well in inundated areas. The pods have high value as fodder and the leaves also are lopped for this purpose. Incidentally a good timber

and fuel. Grows fairly fast in early youth. It is not browsed for the first year because of its thorns and, is useful as a protection against browsing of other species.

Albizzia procera : (H.—Safed Siris. B.—Kori). Easy to raise by direct sowing, believed to grow well in areas occasionally inundated. It has very rapid early growth. It is an excellent fodder.

Celtis tetrandia : Like the above, a good fodder, but grows slowly.

Bauhinia purpurea : A very easy species to raise. Grows fast in youth. It is not badly browsed, if grown as dense hedge to start with.

Terminalia tomentosa : An excellent fodder which will stand occasional inundation. It needs protection from browsing.

Moringa pterygosperma : (B. & H.—Sajna). A very popular fodder, grows exceedingly fast and is very easy to raise, but needs protection. Pigs are great enemies.

Morus alba : If grown in a dense hedge it can be raised without fencing, if browsing is not severe.

Albizzia lebbek : Similar to *Albizzia procera* ; complete protection is necessary, otherwise the plant cannot be grown.

Ficus glomderata : An excellent fodder when fully developed. Can be raised from cuttings before the rains.

Terminalia arjuna : A good fodder tree, easy to raise. A slow grower.

Bauhinia malabarica : Racemose and variagates. These species are easy to grow and fast to start with. They are small trees but yield fairly good yields of fodder.

Schleichera trijuga : An excellent fodder tree for dry climates. Grows very slow when young. It gives a very high quality of fodder.

Pterocarpus marsupium : (H. — Bijasar. B. — Pitsal). An excellent fodder, and an excellent timber. Planting of root and shoot cuttings necessary. Requires protection.

Hardwickia binata : Slow grower, but gives very high-quality fodder.

Ougeinia dalbergioides : (H. — Sandan. B. — Tinis). Similar to the above. Grows best from sowings.

Carallia integerrima : A very good fodder which likes damp localities. Complete protection is necessary.

Azadirachta indica : Raised from direct sowings. Excellent fodder. Requires protection.

Stereospermum suaveolens : (H. — Paral. B. — Parul). An excellent fodder, popular with the grazier. Requires complete protection. It is a slow grower.

Terminalia belerica : (H. & B. — Bahera). An excellent fodder and is easy to raise. Requires complete protection.

Ficus bengalensis and *religiosa* : An excellent fodder species. Raised from branch cuttings. Requires complete protection.

458. Famine fodder : Another class of tree-fodders are necessary for providing fodder during drought and consequent famines. In the drier tracts of India, when there is a failure of rain, crops fail, and grasses wither, and both men and animals run short of food. Food for men might be got by transportation from other Provinces, but fodder being bulky is difficult to transport, and it is not possible to set up

pressing plants at short notice. Transport by rail is, therefore, mostly out of the question for roughages.

During the last century there have been about ten drought periods, averaging once in every ten years. Some of these had been of very great intensity. The famine of 1937-'40 affected Sind, Rajputana and the Western Punjab, and was one of the severest of famines. This famine was caused by want of rain-fall, resulting in complete failure of fodder and grain-crops. The affected areas were by chance the localities where some of the best cattle of India exist. For want of fodder they had to be sent away to places where fodder was available by arrangement, or sold at nominal prices or allowed to starve to death.

It was reported that 4 lakhs cattle died in the Tharparkar District, and about 3 lakhs in the Karachi District. In Rhotak and Hissar the estimated loss was from 30 to 60 per cent. Those that escaped death later succumbed to deficiency-diseases and suffered, thus becoming uneconomic. Vitamin deficiency on account of absence of green fodder was very much in evidence, giving rise to cases of blindness, night blindness, xerophthalmia, abortion, retained placenta and calf scours.

Some trees are usually regarded as famine-fodder. They may have no special merit, but only they should be more popularly known. They are marked with an asterisk in the general list of fodder trees.

There is, no doubt, that the fodder-trees fill a large place in cattle-feeding. They should be given the place they deserve in animal-feeding. Apart from

supplying the general feed, at times of scarcity and of flood, when other resources fail, the trees render great help. It is all the more necessary, therefore, to pay particular attention to the fodder-trees.

During famines even if pressed hay or *bhusa* etc. are given, they can not supply the vitamin needs of the cattle. The cattle fed with dry fodder and concentrates in normal quantities failed to maintain health, and cases of blindness were wide-spread in the herds kept alive at great cost. The reason was the absence of green fodder, and therefore, the want of vitamin A. Here trees fulfil an extraordinary place of utility. Green fodder cannot be dispensed with even in times of famines. The trees supply them. The leaves of trees may be silaged. *Shisham* leaves have been found particularly relished by cattle as silage. There is no reason why the leaves of other trees should not give equally good results by siloing. In un-irrigated dry areas, like parts of Sind and Rajputana, green leaves may be kept in silage for years and only used as reserve materials for times of scarcity.

459. Some other famine fodders : Research on famine-fodder is being conducted at the Imperial Veterinary Research Institute. The possibilities of feeding otherwise useless materials in times of scarcity are being explored.

Reeds, ground-nut husk, *bajra* husk, rice hulls, and molasses have been receiving attention.

Reeds received special attention as the principal roughage for famine periods. They grow wild over millions of acres of land. Their young shoots are

indifferently browsed upon by animals. A fraction of the total produce is utilised for thatching huts. Very generally they are burnt off in the fields when mature. Reeds flourish both in arid and semi-arid tracts.

A reed and molasses ration was made adequate by addition of wheat bran and oil-cake. Before feeding, the reed was chopped to small bits and kept soaked in water. The moistening was done thoroughly enough so that the bits did not prick when pressed between fingers. The experiment lasted for 8 months, and during this period the animals on this test-feed did not suffer in health. Reeds sweetened with molasses cannot be used as the sole feed as they contain no digestible protein. Green leaves or silage or oil-cake are necessary to supply the requisite portion of protein.

A number of calves also were kept on reed-molasses cake ration with a pound of green leaves. The calves showed no deterioration during the seven weeks that they were kept on this feed.

It appears that there are vast sources of potential fodder unutilised, and greater attention to them may to a certain extent go towards relieving the fodder shortage, so much in evidence.

460. More leguminous fodder: In wet or rice tracts, the cows are notoriously ill-fed, and hence they have the most degraded appearance. Rice straw, a very deficient food, is at the root of this under-nourishment. The deficiency of rice-straw may be materially corrected by the more general use, and in larger quantities, of leguminous fodder. Legumes

enrich the soil instead of impoverishing it. Legumes give pulses which may be used as human food, and the dry stalks constitute substantial and nutritious fodder.

Feeding legumes in larger quantities and throughout the year may be made the programme particularly for the rice-tracts. Very generally in wet soil, after the crop of rice is mature and water has subsided from the fields, pulse seeds may be sown broadcast on the standing crop. They germinate and on taking root the pulse seed gets somewhat covered up. On harvesting paddy, the field is sown with legumes which grow well. On reaching maturity these can be ensilaged or dried and kept stored.

The difficulty with regard to them in many cases is that of protection from the grazing cattle. In the rice tracts it is the usual practice for cultivators to let loose the herds on the stubbles. Green blades soon appear after paddy is harvested, and the cattle graze on these. At this period it is difficult to keep stray fields under cultivation. Joint action by the villagers is the remedy. In order that the health of the cattle might be maintained this task can be managed by a living body mindful of the welfare of villages as had been envisaged in the Village Communities. The Village Communities with village *Panchayets* as their executive can certainly control the herds of the village, so that the growing of leguminous fodder may not be interfered with. If the whole village takes to the scheme of growing legumes, then the matter of control of the herds does not come up, as it does not come up when the paddy is in the fields, for every one

is equally interested in the protection of the paddy from stray animals. Similarly, when legume growing becomes a programme of general cultivation, the question of protection against stray cattle disappears.

By growing a crop of legumes all over the paddy area of India, a substantial contribution to the solution of fodder scarcity can be effected. But paddy areas are not the only areas where more legume cultivation is necessary. It is necessary throughout India as a general measure to improve the fodder that more and more leguminous crops should be cultivated.

461. Chaffing—fodder cutting: In many parts of our country, the land of fodder deficiency, fodders even with thick woody skins—like *joar*, *kadbi*, *bajra* etc., are fed to the cattle as entire plants. The cattle eat the leafy and tender portions and leave the rest. The farmer usually dumps these unconsumed pieces on the manure heap and allows his dry and less productive animals to starve. It has been noted that not less than 30% of the fodder is thus wasted, and at the same time animals remain starved. If the fodder is cut into small pieces and then fed, a large part of the wastage will be saved and more cows could be maintained in good condition. Under Berar conditions a herd of 75 animals would normally require 1,500 lbs. of dry *kadbi*, but if the same is fed chaffed, there will be a saving of nearly 450 lbs. which will mean that nearly 30 more animals could be supported on the same stuff.

CHAPTER XI

CONSERVATION OF MANURE

462. The problem stated : The conservation of manure is a subject which naturally belongs to agriculture but has to be considered along with cow-keeping also. Farm-yard manure from cattle constitute one-fourth or rather more than one-fourth of the income from cattle-breeding, being rupees 270 crores in a total of 1,000 crores. It is therefore, worth while for the animal husbandry man to see that the utmost possible output is conserved. Otherwise, a large fraction of the total output may go to waste, remaining only on paper to indicate the possibilities of animal husbandry. By a little care and by using manure for manurial purpose only and not for burning, the greater part of the value of the farm-yard manure may be utilised.

That fuel is a necessity which is met from manure has been a misfortune. Dr. Voelcker had taken pains to show that the Indian cultivator knew the values of manure, and that when he *used manure for fuel*, he did so under a pressing necessity. He, therefore, recommended the intensive practical application of the policy underlying the creation of fuel and fodder reserves initiated by the Government at that time. The Government has not taken action upon this recommendation. And it has been shown in the

previous Chapter, what marvellous opportunities are yet before us in the matter of providing for fuel and fodder. (28, 32, 444, 577)

463. Cow-dung to be conserved : Cattle-dung has to be released from its present use as fuel and conserved for use as manure alone. But fuel replacement is only half of the problem. Of the value of cattle-manure nearly half has been credited to urine. No question of securing a substitute fuel can arise in this matter of the disposal of urine.

In the estimate for valuation of the solid droppings from cattle, these have been shown at Rs. 14/- per year and urine at Rs. 12/- per year, the two together making Rs. 26/- for a full-grown bullock. Half of this amount or Rs. 13/- per animal has been taken as the average of the entire bovine population.

464. Cattle urine to be conserved : We have to conserve not only Rs. 14/-worth of dung but also Rs. 12/- worth of urine from every adult animal. Much of the urine is wasted, and only an insignificant portion comes to be used as manure. Where the practice is of erecting temporary and shifting cattle pens in fields, the urine is utilised, being absorbed by the soil which is cultivated in a few months. But this is done in a few districts and in special seasons. Some means should be found for conserving urine, which is practically as valuable as the solid droppings. Dung and urine, however, do not exhaust our list of manures.

465. Various manures : There are various manures besides the farm-yard manure. Household

sweepings, corn cleanings and harvest sweepings, husks, ashes, stumps, useless leaf and leaf-mould, village wastes, street sweepings, oil-cakes, human excreta, bone and meat from dead animals, the entire body of the smaller domestic animals and pests, such as cats, rats, lizards, cockroaches, moths, are all manures or convertible into manures. If they are returned to the soil after proper treatment and preservation, the productive capacity of the soil will materially increase and the present problem of starving men and starving animals may be very materially solved. This list of manures may be enlarged, because materials which can be converted into manure will run into hundreds.

466. Soil fertility : When plants grow and flower and seed, the natural process is maintained in the plant by the collection of the necessary materials of growth from the soil and from the air. The soil supplies the mineral-contents of the plant body as also the protein-contents, and the air and moisture supply the carbohydrate portion of the structure.

By repeated cultivation, the soil gets denuded of those components which contribute to plant formation. There must be some method of recoupment, so that the soil may not be exhausted. Not only is the maintenance of the plant-forming constituents necessary, but to get better yields of plants their increase is necessary. These plant-forming substances have to be returned to the soil ; and manuring the soil means replenishing or increasing the plant-forming constituents. The more manure is put into

a soil, the greater becomes the power of the soil to produce. Of course, there are limits to the productive capacity of the soil. In India the soil is not being properly manured although crops are being grown from year to year. Naturally, one might think that in course of denudation a point will arrive when the soil will lose its productive capacity. This might have happened in India, but it is not happening because there are natural ways by which the soil recoups the denudation. It appears that in India a balance has been established between denudation by crop-growing and recoupment, partly natural and partly by manuring. It is, therefore, apparent that if more manure is put into the soil now, more crops will grow. Production can be very materially increased in India by scientific manuring.

467. Conversion of fodder into manure : It has been mentioned how villagers near forests utilise *forest grazing*. They keep any number of cattle, and in return take particular care to get the droppings which they use as fuel. In this case, the villagers use cattle as the medium for converting leafy structures into manure and subsequently into fuel.

* What happens in the digestive mechanism of the cattle may be otherwise conducted outside. The digestive mechanism digests the leafy structures and converts them partly into blood and the rest into manure.

After digestion a lot of living and dead bacteria is thrown out with the droppings. These can be utilised for the work of converting leafy or soft

vegetable structures into manure. If fresh dung is mixed with water and the fluid sprayed on leaves and soft plant structures, such as straw or stalks of plants, bacterial action commences under certain conditions and the leafy and other soft vegetable structures are converted into manure. This process of converting leafy and other vegetable and plant refuse materials is called *composting*.

What is performed by the bacteria from the dung can be performed by human excreta also. Human excreta can also be used for composting.

468. Conserving manure: The dung of the cattle is part of the farm-yard manure. The dung when exposed to the sun, air and rain loses much of its manurial value. It has, therefore, to be conserved for use. There are certain garden-processes by which raw manure may be trenched and conserved. Plants on either side of the trench draw upon the manure as it gets matured, and there is no waste. Guinea Grass plots, lying about dairies, can be very successfully manured in this way. The grass is planted in rows. In the intervening space between rows, shallow trenches can be dug and filled with a thin layer of dung and immediately covered. The grass roots from either side send suckers and get fed on the manure. Nothing of the manure is lost and the grass shows immediate improvement. Trenches may be dug in rotation and thus a requisite number of acres may be kept continually and fully manured from the daily dung-receipts from the cattle-shed.

All plants will not respond well to this treatment. To some, the fresh dung may act injuriously. Fodder grasses are, however, responsive to this treatment, and thrive in the process of trenching. Other waste materials from the farm-yard and household may also be put in along with the dung and urine. This daily utilisation keeps the surroundings of the cattle-shed clean.

Daily trenching is, however, not applicable to crop-cultivation where the entire field has to be evenly manured in a few days and ploughed, dressed and made into a seed-bed. For this purpose the dung has to be stored and matured.

469. Storing cow-dung : Cow dung has to be stored in a pit. Where means permit of the erection of a masonry pit, this can be made. The size of the pit will depend upon the number of cattle. Large pits are to be avoided. Several small units are preferable. The pits may be emptied and the manure used every three months. As one gets filled another is used for receiving, while the one in which the top layer has been old is emptied out.

Where a masonry structure is not possible sticky clay is the material of choice. Where the water level comes near the ground the pit should be made above ground with thick mud walls. It is always necessary to have a shed over the series of pits to protect the contents from rain. Rain and sun spoil the materials. The dung has to be protected both from the sun and rain. There should be an inside lining of clay. A twelve inches layer at bottom above the water bed and

a six inches layer at the sides, will be ideal. From such a pit fluids will not be able to escape. The wall should be built in layers, just as they build mud walls for huts. The outside of the pit above ground should be protected by a very thick abutment walling, sloping from the top to downwards. Another suitable method of storing cow-dung manure is to cut long trenches, say, 3 ft. deep \times 5 ft. wide. The pits may be filled in and covered daily. The mature portions may be used at the tail while fresh manure filling goes on at the head.

The height of the walls or the depth of the pit should not more than four or five feet. The higher it is, the stronger and thicker should be the abutment. In the above-ground pit, the dung will have to be carried up along the slope.

470. Collecting cow-dung : When the cattle are stall-fed, as in the case of dairy milch-cows, the droppings of both the day and night may be collected. When, however, the herd is sent out on the pasture, care should be taken to collect the droppings. Two baskets lined with a plaster of dung may be used, they being connected together by a rope which can be slung over the back of any animal of the herd.

A pair of sheet metals six inches wide and twelve inches long and doubled on three sides should be carried with the baskets to scrape off and lift the droppings into the baskets without soiling the hands.

When bullocks are used for carting, it is a practice to put a pad of straw on the cart platform as fodder for the journey. A thrifty carter may make it a

habit to carry a basket below the cart frame for collecting the droppings from his animals during the journey, so that a return for the feed in the shape of dung may be brought in.

If the cost of maintaining a pair of bullocks in a village is estimated at Rs. 100/- per year, the value of droppings alone will be repaid by Rs. 25/-, and if the urine could be conserved, by another Rs 25/-, or half the cost of feeding could be obtained from the excreta. This consideration must weigh sufficiently with the discriminating and intelligent animal husbandry-man. (30)

471. Waste of cattle urine: The urine is rarely conserved. Where the cattle are allowed to graze during the day and kept in the shed at night, the dung from the stall is collected but the urine is allowed to be absorbed in the *kuccha* floor. If the floor is of sandy soil and the ground also sandy, all the fluid is absorbed and disappears. On the clay floor the urine is not wholly absorbed but gets mixed with the dung, and that portion is conserved.

Careful cultivators slope the floor in such a way that the urine runs along a drain and is collected into pits; there may be manure pits when these are placed under-ground or a pit having a large earthen-ware vessel. When the soil is of hard clay well rammed, there is not much waste of urine.

472. A dry soil absorption method of conserving : The urine from the shed can be better conserved by keeping a depth of loose earth on the floor and removing this and spreading another layer when the

first layer is saturated. For saturation the floor may be raked up and the layer turned. This method has been tested under practical conditions. In the test the old method of heaping the cow-dung was done on one part, and on the other, the dung was kept in a pit under a shed and covered with a layer of earth to which was added earth that had absorbed urine from the floor. The experiment showed that the floor absorption-method, combined with the earth layer pit system called hereunder "urine-earth" system for manure, gave twice the yield of the old process. Some details are given below. (Singh & Rasul. *Agriculture and Live-stock in India*. July, 1933. P. 352).

473. The urine-earth system : The urine-earth method practised at Lyallpur (Punjab) was compared with a control experiment of the old method of keeping the dung in a heap. Lyallpur is a place of low rain-fall. Two pairs of bullocks were taken. They were fed the same materials. The dung of one pair was stored in a heap in the usual way and that of the other pair was preserved by the urine-earth method. The pairs were changed after half the time, so that even quantities of droppings were ensured for each system—half the dung went to the open and the other half to a covered pit. The dung was kept in a pit, for here at Lyallpur there was no chance of water percolating inside the pit. To keep away the rain and the sun a light shed was built over the pit.

(a) In the urine-earth method for one pair of bullocks, urine was absorbed in a layer of silt and earth about 6 inches deep spread on the floor of the

bullock-stand and kept loose by digging, as required. The dung was removed and put in a *kuccha* pit covered with a layer of earth about 3 inches thick, once a week.

(b) In the other experiment the dung produced by one pair was collected and stored in an open heap. The experiment was conducted for a period of 230 days. The total rain-fall during this period was 3·87 inches only, the heaviest rain-fall in one day being 1·8 inches.

474. Comparative estimate of urine-earth conservation : At the end of the experiment the urine-earth and the manure from the open heap and the covered pit were weighed and sampled for analysis. The results are given below :

TABLE—31

Description.	Open heap method. lbs.	Urine-earth & improved method.	
		Solid manure from covered Kachcha pit. lbs.	Urine- earth. lbs.
Total quantity.	6,091·2	12,056·9	8,290·3
Total organic matter.	2,520·4	2,103·2	...
Moisture percentage.	35·05	68·30	7·9
Percentage of nitrogen in original sample with moisture.	0·2400	0·1563	0·1449
Percentage of nitrogen on basis of dry matter.	0·3695	0·5273	0·1563
Total quantity of Nitrogen present.	14·62	18·84	12·01

The total quantity nitrogen in the collection was double that of the old way. Even in the dung alone, storage in the open and in a pit under cover with an earth layer showed nearly 30 per cent increase. The urine gave an additional 70 per cent ; in all there was a little over hundred per cent increase in manurial value. The extra labour to handle the manure by the improved method was as under :

TABLE-32

	Man hours	Bullock hours
1. Cartage of earth from and to the field, and digging the floor when required.	88	16
2. Compacting dung in the pit, sprinkling water and covering it with earth.	48	...
3. Carting extra water and added earth to the field in case of pitted manure.	8	4

From the extra weight obtained it appears that about 5 cart loads of earth had to be brought in for the treatment of one pair. The quantity of earth will be materially less in case of a herd. For, whatever be the quantity of dung, a 3 inches layer of earth will be spread per week.

In a large herd a substantial quantity of dry earth would be necessary for the absorption of the urine. In this experiment 3 carts per pair of bullocks for 230 days, brings it to $4\frac{1}{2}$ carts for the year. A rather large quantity. It has to be seen if less earth could absorb. If household ash is included in the absorbing material much less earth will be required, as ash is highly absorbent.

The experiment was conducted at Lyallpur, a very rainless place. Experiments made under different rain-fall conditions will give an idea of the requirement of earth for absorption. In areas of heavy rain-fall, and in the deltaic areas, the pits should have to be constructed more or less above ground. In these areas earth to last the year will have to be brought during the dry season and kept stored under sheds. This will require also additional space. These are the extra difficulties. But the reward is enormous in the greater out-turn from the same acreage.

475. Refuse, sweepings, shrubs and other materials for manure: Various organic materials may be easily, simply and quickly converted into manure by the bacterial action of the excreta. The materials used may be household sweepings, corn cleaning husks etc. unsuitable for fodder, vegetable refuse, leaf and leafy refuse, stubbles from fields and jungles, bushes and other tender leaves and the twigs of plants useless as fodder, water hyacinth, decayed grass and any vegetation. These may be converted into manure by starting bacterial action from cow-dung (or human excreta). The process is called composting. By composting larger quantities of manure can be obtained and utilised for increased production from the soil. In fact, in composting there is room for every organic vegetable material to be converted into a rich manure.

The process depends upon the bacterial action of a 'starter', such as cow-dung, in the presence of air and moisture. Air and moisture in plenty are essential. The

process is just the opposite of ensilage where we have to keep the materials entirely out of contact with air.

476. Composting : site : A site should be selected for composting where the ground is high and there is no risk of water standing, or being flooded during the rains—a shady place suitable to prevent quick driage. During the rains care should be taken that excessive down-pour does not wash away the formed manure from within the heap. For this reason in tracts of heavy rain-fall a light structure should be erected over the composting site.

A site near a source of water and near the cattle-shed may be suitable, for these materials will have to be carried to the compost.

Area of composting : Composting is made by spreading vegetable and refuse materials on the floor of the site to the thickness of a foot. The width of the compost heap should be about 6 feet. The length should be according to the supply of the materials available. It is better to have a number of small heaps of about 16 feet length. The heap should be 4 feet in height in layers of 1 foot each.

Moisture : Green or wet materials should be used for composting. Dry leaves and other dry organic matter should absorb water before coming to composting. A good way is to use dry materials as a litter in the stalls where these get soaked in the urine and take moisture from the dung also. The treatment necessary for moistening should vary with the materials. When such a watery material as water hyacinth forms part of the heap, comparatively drier materials may go

with it without moistening. The climatic conditions should also be considered. Dry climate requires more moisture to be put on the stuff.

Heaping : Materials are spread lightly over the soil for a depth of one foot, without treading. If there are much bush-like plants they should be cut up or the branches separated before putting in the heap. After a layer of materials has been put, a two-inches layer of cow-dung has to be sprayed over, or better, an equivalent quantity of dung should be mixed with the mass with the help of water, and heaped. It is followed by a thin layer of earth where convenient, and the whole is sprinkled over with cattle-urine and cattle-shed washings or cow-dung mixed with 15 times its weight of water. After the first layer, a second, a third and then a fourth layer has to be heaped. This will complete the stack. At no stage should the stack be trodden upon for compression. Inter-space air is the very life of the process. By treading or ramming this air is forced out, hampering the act of conversion. When the stock is finished the top may be sloped slightly.

The heap should be examined from time to time to see that enough moisture is present. If it is drying up, water should be sprinkled over it. When very wet materials like water hyacinth forms the chief material, some dry materials should be incorporated, such as dry bamboo leaves or other leaves or dry straw, or stubble. These should be moistened in cattle-urine and stacked.

Completion of the conversion : For completing the conversion it is necessary to break up the stack and

rebuild it. When the process is well advanced and it appears that half the material is converted, then it will be time for breaking and re-stacking. For dry materials it takes about 6 weeks, whereas for very watery material half this period or only 3 weeks will be necessary to complete the first period of conversion. After this the stack is broken up from its site and re-heaped near it. During this breaking up vertically and re-stacking, the materials get thoroughly mixed. The harder twigs and sticks will have shed their bark and soft materials. These are then to be kept out of the heap. Woody, hard materials, thus separated, may be dried and used as fuel. In re-stacking, the order of layering is reversed. What was on the top goes to the bottom, and the bottom materials come to the top, layer by layer. The more refractory materials should be put at the centre of the stack. If there is evidence of dryness, water mixed with dung (15 : 1) should be sprayed.

In another 3 to 6 weeks the compost will be ready for the field.

Composting is completed quicker during the rains than during the summer or winter. Generally 3 to 3½ months time would be the mean period. Very stiff materials should be pounded by beating. Materials like husk should be spread lightly over leafy layers so that the interstices might not get filled. It is a good practice to use dry materials as litter for the bed of the cattle, to be soaked with urine, before composting. The same applies to rice husks.

477. Manure : utilisation of human excreta : Human excreta is more valuable even than the excreta

of the cattle as manure. In cities where there is flushing and the sewer system, the excreta is carried away with the drainage, and is lost. But in most of the towns the excreta are handled by men and are trenched. This is a wasteful method. A better method in composting is the use of the town-refuse as the starter of bacterial activity. Town-refuse can be converted along with night-soil into manure efficiently and quickly by the Indore system. In villages, however, a different method should be adopted to convert excreta into manure. It can be done by trenching. A travelling latrine over a trench under a covering shed will be ideal. Much of the nuisance of the villages might thus disappear, if trenching of excreta is adopted as a general practice. Water should flow away separately and not allowed to mix with the excreta. Should water come in contact, the excreta becomes in a short time converted into a fluid and it is difficult then to get rid of the foul odour because such a material cannot be kept covered by dry earth. It is, therefore, necessary to so construct and use the trench that only excreta gets in it, the urine and the wash water being carried away by a surface drain. After use the excreta is covered up with dry earth which must be separately stored in a dry state for this purpose. In three to six months time the excreta gets converted into earth and becomes a harmless material fit to be handled and taken to the field for manuring.

478. Manure from dead animals : Dead animals may be utilised as manure after the skin or hide

has been taken off. By chopping the body and by boiling, the fat is separated, and the bone and meat can then be fried over a pan. The product can then be separated into dried meat and bones. Dried meat can at first be put under earth. In three weeks the mass gets converted into usable manure. The bone should be charred over a light fire to make it friable. Charred bone can be powdered under *dhenki*, sifted and used directly in the fields for manuring.

Small animals, pests etc. may be buried under the earth and later used as manure. .

These and many other sources could be found if one became manure-minded and wanted to increase the output from the soil, which has to be done to save the cow. When more cereals and grains will be turned out from the same acreage, then it will be possible to set apart a fraction of land for fodder and thus save the cow.

479. Oil-cakes as manure : Uses of oil-cakes are known, and they are used in some localities for special crops. Their use may be further extended. The return that comes to India by export of manure is nothing compared with the return that will accrue by the use of oil-cake manure on a larger scale.

Manures, whatever be their name and source, are saviours of the cow when applied to the soil, as they increase its fertility and thereby make room for growing fodders. (27-'9, 547-'51)

CHAPTER XII

IMPROVEMENT THROUGH THE BULL—MILK-RECORDING AND HERD REGISTRATION

480. **The scrub bull pest :** A scrub bull is a degenerate bull not developed for the purpose of breeding. To-day the scrub bull has become a real pest, for it is this individual who is propagating the species in the largest number and is bringing the breeds of India down and down in quality. But why is he allowed to do so? We shall try to understand the position. (143, 513)

481. **Village community and the scrub bull :** Reference has been made to the *Village Communities* that made up India in the past. These institutions took up some matters as their own concern and acted as the State in those matters. Providing of bulls for the village herds was one of the items which the village communities took upon themselves as their duty. The burden or responsibility for providing proper bull service was taken off the hands of the *ryot*; it was the concern of the corporate body—the community and not of the individual. The individual was, of course, a part and parcel of the corporate body. This custom had originated in the forgotten past and became a pattern of village life itself. The

community had its own machinery for achieving the end. It was made a religious duty to present good bulls to the community for those who were able to do so, and it was the duty of all the families of cultivators in the villages to maintain the bull in proper health. This institution worked well, and along with the favourable conditions then prevailing, it contributed to the creation of the excellent breeds which we now know by their loss, that they had existed in abundance.

With the extinction of the Village Communities after British conquest, the form of the institution of the dedicated bull remained, but life went out of it. The token or symbol of the extinct practice still exists. Still, practically all over India, during a *Sradh*, bull-calves are dedicated. But it is a lifeless practice, distorted from its original purpose. Any bull-calf, anything that comes cheap, is dedicated and allowed to roam about in a village. The guiding body being defunct, there is no one to regulate the number or see that the existing bulls are properly cared for and fed. There are places where the bulls, so dedicated and maintained by the public, have got so few in number that it is a matter of concern for the herd-owner to be fully sure of a bull when the cow comes to heat. As there is no choice in their selection, so there is no feeling of responsibility about feeding them. They are left to their fate. The evils of the present practice regarding bull service would be apparent to even the most superficial observer. Generally speaking, as the cows are under-fed, so also

is the bull service in the most degraded condition. An awakened society may take up the problem and end the mismanagement that exists. Individual families had never thought of the bull. They depended wholly upon the village communities to do this work for them. While the village communities have become extinct, religious practice still provides a number of weak, indifferent or inefficient bulls, incapable of casting a high-class progeny. And the individual herd-owners do not look beyond their immediate horizon. That the cow is deteriorating, he knows. The bull is a scrub one, not worthy to be the sire of the herd of the village. This also the herd-owner knows, and knowing all these he does not know where the remedy can be found for the individual families, owning one or two or ten cows, cannot afford to maintain a bull.

This is the miserable plight in which the breakdown of the old institutions has brought India—breakdowns without anything to function efficiently in its place. (143)

482. **Scrub bull :** the costliest bull : The villagers willingly or unwillingly often maintain the scrub bull and, therefore, even in their poverty maintain the costliest bull. For there is no bull as costly as the scrub bull, He takes his feed, be it a full or a starving ration. But he gives the service which brings down the quality of the herd. Is he not costly even if maintained at starvation ration or driven from field to field in the days of harvesting ? In America it is recognised that a scrub bull is the costliest bull.

The scrub bull should disappear. Wherever villagers want cattle welfare, it should be a practice to rear a selected and the really best possible male-calf for making the bull. If feeding at random by the entire community is not satisfactory, quotas should be raised from all owners of the cattle, according to their capacity and according to their herd, and the bull should be maintained by stall-feeding. The old



Fig. 34. Scrub bull—the most expensive type of bull in the world.
(Live-stock of Southern India.)

tradition should be revived and the existing scrub bulls should be castrated.

Reference has been made about *breeding in the U. P.* where the villagers willingly come to the authorities for the supply of the better-class bull and agree to castrate all scrub bulls from the area where the premium bull is to serve.

Whether the Government or District Boards supply the bull or not, it is for the villagers to secure the best bull-calf of the locality and rear it to serve the herds.

This is one item of improving the breed and a very important item. In *selecting a bull-calf* care should be taken to see that the calf is of the same breed that it is going to serve. If it is of a mixed breed the predominant character should be sought out and a calf selected to meet the requirements. (143)

483. Supply of better bulls by Government : The Government have been encouraging the introduction of better bulls from well-known breeds. But the speed is slower than that of the proverbial snail. India can never improve the breeds of cattle if the supply of better bulls goes on at the rate at which it is going on. One can determine the number of cows and calculate one bull for every 50 or 60 cows. This is the initial requirement, and this number is to be replaced annually by, say, one-fifth. For, the active service period on the average cannot be calculated at more than five years at present. To meet the enormous demand for good and improved bulls it is necessary for a body like the Village Community of the old to be set up and work out the miracle. The modern attempt is to fit in any such organisation with the trend of the present centralised administration. The new organisations are named **Breeding Associations** or **Breeding Societies**. In their very conception they are too official, too out

of touch with the life of the villagers, to be of substantial use.

From the various Government measures taken for the supply of improved bulls, one fact comes out clearly. It has been discovered that the Government cannot supply all the improved bulls necessary for India from their own breeding farms. Some provinces have, therefore, adopted the policy of intensive breeding in areas where suitable types exist, by supplying approved bull in those areas. After a time the bulls produced in these villages will be approved bulls and will be available for distribution where that particular breed or strain is needed. This is a move in the right direction.

Wherever such intensive breeding work is undertaken it becomes a condition precedent that all scrub bulls should be castrated. By this sort of intensive work the Government may in a few years build up breeding villages to supply gradually the needs of the whole country in this direction. (142-'43)

484. The exchange of bulls : The intelligent breeders know it well that by maintaining the same bull in the herd, it is made to serve its own sisters and daughters, bringing in the disadvantages of in-breeding. To avoid this, he either sells it or breaks it to the plough. Many a time some very good bulls are thus lost ; but if they had been transferred, they would have produced many useful animals. It is not always possible for the breeders to sell their bull and purchase new ones in their place. Much of this trouble could be saved by maintaining bulls on co-operative basis.

As for instance, three breeders A.B.C., interested in the same breed, purchased co-operatively in 1940 three bulls X.Y.Z. and distributed them among themselves.

Breeders A.B.C. use the bulls X.Y.Z. respectively up to the year 1943, when the bulls change place. A. has Z; B. has X and C has Y; and again they shift in 1946. A. gets Y., B. gets Z. and C. gets X. Thus all the three breeders will get the advantage of all the bulls. (Fig. 35).

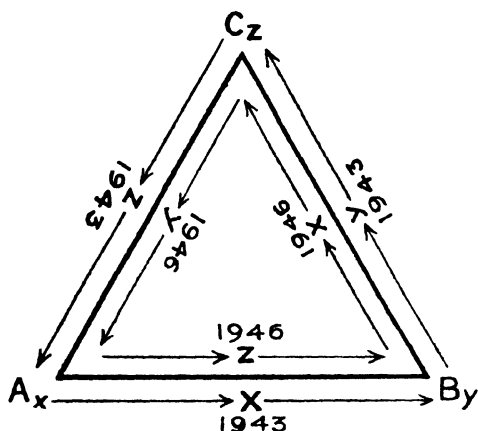


Fig. 35. Co-operative exchange of bulls.

If in the meantime any bull is found unsatisfactory, it is replaced by a new one. In this way the bulls are tested and their full use is obtained economically. (143)

485. Nandi-shalas : The old age practice of the community providing breeding bulls still exists in many parts of the country. The form remains but the spirit has gone. Very cheap specimens of the breed—if there is any—are selected, branded and dedicated

in the name of the deceased. The animal is allowed to roam about and get whatever he can from the fields. He is everybody's property, that is no-body's. He is driven from field to field and always being cursed. Such a breed, and an uncared-for animal belonging to it, is sure to reproduce inferior stock. Being a dedicated animal, it can neither be castrated nor used in the plough.

In order to be more useful a new turn should be given to the institution. Only the best animals should be allowed to be dedicated. They should be placed in charge of the local Goshala or the village headman, or the village temple or any other reliable worker. The feeding and other expenses may be met by levying a tax in kind on the cow-keepers. The cows are to be brought to the bull for service. During spare time some light work like hauling of the village refuse, drawing water for the village cattle etc., may be taken from the animal to keep it in a good condition of health and to be of some use to village community work. Such common places for keeping dedicated bulls once existed and were used to be called Nandi-shalas. (143)

486. The production of high-grade bulls : The want of high-grade bulls has greatly hindered the progress of mass cattle improvement, and it gets very difficult for progressive breeders to get bulls that will suit their standard. In many provinces attempts are being made by the Government to produce and distribute bulls for breeding purposes. But they have not been able to cope with the work. On the other hand, there are progressive breeds scattered all over

India, maintaining some of the finest specimens of the breeds. But they cannot dispose of their home-reared bulls for want of proper advertisement and necessary credit. A working plan co-ordinating these agencies will prove to be very beneficial in solving the problem. A improvement plan may be suggested as follows : In the locality where cattle work is to be undertaken a model farm should be started. Some 50 of the best available cows of the proposed breed should be maintained, headed by the best possible bull. Selected bulls from the herd will go to service the cows of the certified breeders. These certified breeders will carry on these operations on scientific lines. Their approved bulls are to be purchased by the Government and distributed in the locality. Things are so arranged that one bull serves three herds in a life time. If well-managed, one model farm will be able to supply enough bulls for at least 50,000 cows. Concentrated working in any locality will alter the face of the cattle within about 10 years. (141, 143)

487. The scrub cow : milk recording : In order to put more milk into the existing breeds, better bulls of these breeds are, of course, necessary. In this work merely supplying good bulls to breeding villages is not enough. The draught quality and size may be transmitted by selection from the appearance, but for milk-quality, no outside guide is available. Bulls have to be tried on approved cows, and seen how the progeny has responded. For this work a selection of the cow is also necessary. Scrub cows are not needed, for they will continue to do harm. The question of eradication

of the scrub cow will be considered later. For our present purpose, a selection amongst the existing cows is necessary. The cows should be selected on the record of their milking capacity and the interval of calving, and health, and freedom from disease. Once a cow is so selected, she is to be mated with an improved bull, and the performance of the progeny is to be observed. When a cow and bull are found on test to be able successfully to transmit the desired qualities, then as far as that pair is concerned, it would be expected that the future progeny would also breed true to the type. Such a cow will be worthy of being sought after for her off-springs. But how is she to be marked out unless a reliable agency is set up to identify her and certify about her performance ?

488. Necessity of milk-recording : Here steps in the necessity of milk-recording and the establishment of milk-recording societies.

Now a days when one wants to buy a cow in the market, he sees the milking in his presence and buys where such arrangements exist. Otherwise, the buyer has to depend upon the appearance of the cow, and take chances. He strives to pay an unremunerative price for the cow, and reasonably so, because he is in the dark regarding the performance of the cow. Where the selling is done on the result of one milking, there is something to go by to evaluate the cow. But this also is a play of chance. Tricks may be adopted by the seller to show an exaggerated output during that milking by not milking her the previous evening. Here also all the three parties concerned

may suffer. The seller suffers, for, in spite of his showing the performance at one milking the buyer is bound to suspect the *bona fides* of the normality of the condition of the cow for that milking. The seller may not get what he deserves. For the same reason, the buyer also may suffer by being over-circumspect or over-confident. By being over-circumspect he probably loses the chance, and lets go a good cow. By being over-confident he may pay a price which he later on regrets on fuller trial. The cow suffers in both the cases, because the seller and buyer cannot evaluate her at her true worth. (253)

489. Cow selection for purchase : In certain city markets, particularly in Calcutta, there is a custom for bringing the milch animal to the cow-shed of the purchaser with an attendant from the seller. The cow is milked for three consecutive days, and remains under the care of the seller. After three days the average daily milk-yield is determined and the stipulated price of the cow, based on her milk-yield, is paid. The seller agrees to this arrangement when he knows his customer by previous contacts. This is much better than buying after a single milking.

Still, these three-days milking does not reveal everything. How long is the cow going to yield at the rate found out ? Will she diminish her flow or will she increase it during the second month ? These are the questions that weigh with the buyer. Although he is bound to pay the stipulated price, still he buys an uncertain animal which may fall short of expectation or exceed the expectation. Even in a

three-days trial, therefore, the cow suffers. She remains a suspect, and full credit for her performance may not be beyond question. If she exceeds expectation the seller would feel the injustice and become circumspect about breeding valuable cows and properly maintain her from the moment of her birth. It has been explained already that breeding begins with the calf in the mother's womb. Any neglect, ante-natal or post-natal, is bound to reflect adversely on the constitution of the cow. These are obstacles to good breeding.

490. **The cow should have her certificate :** If the cow is to be given her due, she should be a more or less certain item to the buyer. The more she approaches a trade-mark article the more she gets even chances. The seller brings her to the market with all the history behind her, and the buyer buys her, knowing full well what he has been buying. On both sides the cow gets a true and exact valuation, and is, therefore, assessed on her own merit.

In order, therefore, that a good cow may fetch good value, arrangements should have to be set up so that she may be fully known. If the keeper of the cow keeps a milk-record, one part of the difficult business is accomplished. But the milk-record does not and cannot give full satisfaction to the buyer who would like to know about the performance of the parents of the cow, and that most naturally. What was the story of her mother? How did she behave with her milk? What was her age at the time of covering, and how much milk was the mother of the cow

giving per lactation ? These are pertinent questions. On the sire's side also : who is the sire of this cow ; what is the record of her sire ? All these questions may reasonably arise. If the sire of this cow is seen to be the sire also of other cows who have been giving good milk, the presumption would be that his daughter, the cow in question, may also turn out to be as good as her sister. Thus the necessity of examining the pedigree of animals arises. This necessity, if met, dispenses with most of the uncertain items about a cow, and the cow gains. She is able to appear in her true colour with a record of her own past milkings and also about the performances of her parents. To deny the cow such a chance is to do her a dis-service, and put a hurdle on the improvement of the cow.

491. Pedigree registration : The pedigree of the cow is registered in a book called Pedigree Register or the Herd Book. The name "herd-book" has become more familiar in India.

We have now arrived at the conclusion. And considerations have led us step by step to accept this conclusion that for saving the cow from her down-trodden state she must be allowed the assistance of : (1) a Milk Record ; and (2) a Herd Book. These are the two essential steps in the improvement of the cow, which means saving the cow.

In other countries the introduction of milk-records has done a great deal towards the improvement of the cow. The records began to be kept by associations which were named Cow-Testing Associations.

492. Cow-Testing Associations : The first Cow-Testing Association was started in Denmark in 1895. It became very popular with the Danish farmers. Through their advocacy, it has spread to every dairy country of the world. The first association in America was established in 1905 at Fremont Newaygo county, Michigan. From that time the movement has been spreading steadily. In 1938 there were 1,106 associations in the various States of America. Lately, these associations have begun to be called Dairy-Herd Improvement Associations, which they really are. In Denmark in 1934 there were 1,579 Cow-Testing Associations with 48,948 herds and 6,78,402 cows. There are areas in Denmark where as high as 70 per cent of the cows are tested.

493. The Dairy-Herd Improvement Association Organisation : The plan of organisation is simple. Fifteen to twenty-five or more farmers adopt the usual form of constitution and elect officers and agree to put a certain number of cows on test. In America the cost per cow for one year varies from \$1.50 to \$2.50 depending on the place, also the number of cows and of the members. The association then hires the services of a tester. Usually the tester visits the farm of each member once a month, throughout the year. He weighs, samples, tests the milk of each cow and then determines the fat-percentage of each one of them. This is used as a basis for calculating the monthly fat-yield. For the rest of the month the milk-yields for every cow are entered in sheets ruled for the purpose. In another sheet a record is kept of

the feed given to the cow. The recording work of the months is looked after by the tester, who makes a summary of production and cost of feed for each cow at the end of the year. The testers in course of their duty come in contact with many dairy men and are able to gain much valuable information which they pass on to the other farmers.

494. Cow-Testing in Denmark : In Denmark these associations get affiliated with the Government which helps each association with an annual subsidy, provided there are at least 10 members and 200 cows. The association in return has to supply a summary of the production from each cow. The Government keeps the official Herd-Book showing the pedigree of the registered animals. There is a minimum requirement to be fulfilled for being entitled to an entry in the official Herd-Book, depending upon the records of the Cattle-Testing Association Records.

The Government sends consultants to farmers who are whole-time men, devoted to the improvement of dairy and to dairy-cattle work. Denmark has made phenomenal progress in dairying through the help of the Government and through the system of Cow-Testing Associations. In this country the average production of a cow was 110 lbs. of fat a year, and the total export was 26 million pounds of fat in 1911. In 1934 the average production went up to 298 lbs. of fat and the export to 330 million pounds.

495. Registration in India : A beginning has just been made in India. The Imperial Council of Agricultural Research has started keeping milk-records

and herd-books. Provincial Animal Husbandry Departments look after the work. Animals can be registered with the Provincial authorities by writing directly to the Secretary, Imperial Council of Agricultural Research, which puts the enquirers in touch with the Provincial Organisation.

In Europe and America the test consists of the weight of milk obtained and also of its fat-content. In India the work is, for the present, restricted to the taking of milk-weights only and not of the fat-contents. No fees are charged by the Government at this preliminary stage. The milk tester employed by the Imperial Council of Agricultural Research visits the farmers every fortnight and takes the record of milk obtained in 24 hours. From this, according to a formula adopted by the I. C. A. R., the total milk-yield for the fortnight is calculated. This is done till the end of the lactation, month by month, and the farmer is saved the trouble of keeping daily records himself. This is a good system to start with.

Herd-books have also been opened at the Centre at Delhi. It is now for enterprising farmers to get into touch with and get affiliated to this body. This has a great future for cattle improvement, if properly conducted. For example, if any of the progeny of the registered cows are to be sold, they will certainly be sold upon their preformance and not on chance, and are sure to fetch more value than an ordinary animal would fetch. This is not the only aspect. By this process bulls are sure to be discovered which are specially prepotent for transmitting milk-quality

to their daughters. The knowledge that such bulls are in such herds will allow the progeny of the prepotent sires to be spread, leading to the general uplift of the cattle.

496. Elimination of scrub cows : In judging a cow, records are not the only factors. Records of milk and pedigree will certainly give some information. This information again should be evaluated. Other personal factors have to be considered along with the records. Conformation is a very important point. Men accustomed to judge cows can indicate with a good deal of certainty her place in the breed. There is sense in judging by appearance of the milk quality of a cow. About heredity also, mere personal figures of record also are not enough.

It must now be quite plain that the scrub bulls are to be eliminated for the improvement of the breed. Similarly, it is equally important that scrub cows should be eliminated. Neglect of the one or the other will result in the creation of indifferent herds which will not go much towards solving the problem of saving the cow.

The question of elimination in the case of scrub bulls is easy by castration. But the question of elimination of bad or uneconomic or useless cows cannot be done on the same lines. It is not possible at the present stage to make a cow sterile at will. But such a cow has to be prevented from reproducing for the well-being of the race.

When a *ryot* has a cow which the community may think undesirable to breed, and which he may himself find to be uneconomic, and therefore, undesirable to

be kept in the herd, it has got to be eliminated. This cannot and should not be done by sale to others for breeding. For, it is unwise to pass off to others an objectionable animal without making known to them the defects. She can be sold off for slaughter to butchers. But where sentiment is against it, passing off quietly to any purchaser will amount to selling for slaughter, because the uneconomic cow will ultimately find her way to the slaughter house. To prevent this, it would be in the interests of the discriminating farmer to put her to draught use for whatever she is worth, and to keep her separated so that she may not contact a bull.

497. Two classes of attle to improve : There are again, throughout India, different tracts with their peculiar problems. But a general point of differentiation may be created on the basis of breed. There are areas in which certain definable breeds of cattle exist. A few have been listed and enumerated and the work is an expanding one. This is one class of tract. There are other tracts where non-descript cattle exist. Their relation to any particular breed cannot be traced, but they are supposed to be the descendants of the original small hill-type cattle.

These occur mostly in the wet or rice-areas. In the dry tracts of the Central Provinces and in Central India such cattle also crowd the plains. The question of their improvement is quite distinct from the improvement of those of distinct breeds.

Distinct breeds result as the work of selected propagation through many generations. After a time

the type gets fixed through changes. Then the cattle with the type-stamp are expected to breed with the characteristic features. The special features, the colour, the shape of the horn, the size, the character, all tend to conform to a standard, and when that standard is achieved, a breed is established.

The origin of such a breed may have been by crossing. But after crossings had taken place the new blood is worked on in the area sufficiently long and sufficiently persistently to bring forth those characteristics that constitute the breed.

498. Cattle of particular breeds : In considering a problem of improving the individuals of a breed, many of which are not showing satisfactory performance, the question of grading up comes in. A better bull is obtained and the bull stamps its better character on its progeny. At first, the new blood is halved. This is in the first generation. If the progeny of the first generation is mated to the improved sire, the second generation will be of three-fourths improved blood, and then in the next or third generation, if the mating is again with the improved blood, the result will be seven-eighth improved blood and only one-eighth original blood. In such a case the process is called grading-up to pure breeding. When in course of descending progeny the new blood fills practically the entire field, the resulting animal is a pure-bred animal.

In a pure-bred animal certain characteristics are passed on unchanged to the progeny. Hence the necessity of breeding to purity. There is room for

improvement in pure-breds also. The fact that a cow or a bull is pure-bred for a breed does not mean necessarily that it is the best of the breed. It implies that the animal shares the general characteristics of the breed. If in a herd of such pure-bred cattle, a bull occurs which has got the capacity of improving the milk-yield of the daughters over their dam, the bull will be a prize bull and will contribute towards improving the herd of the pure-breds.

The steps, therefore, are, in a herd of known breed, to get a pure-bred bull of that particular breed and by working for three or four generations convert the entire herd into a pure-bred herd, and strive on to improve the quality of the herd by selection of better and better bulls.

499. Difficulty of progressive improvement : To begin with, it is an easy work to observe marked improvements. But as the quality desired rises higher, it becomes more and more difficult to make further improvements. On the contrary, there is every chance of, say, the milk-quality falling down even when all care is taken in the selection of a bull. Individual factors come in, and even with the best care it may sometimes be found difficult to maintain the high standard once achieved.

The endeavour should be not to produce one cow with a high record but to lift the whole herd to a high level so that, apart from individual performances, the whole herd shows excellence on the average also.

500. Attainment of excellence in the average : All the wisdom of the breeders is concentrated on

this subject. The methods are common, namely, the employment of the proven bull. A proven bull is a bull which has been tested by the milk-yield of his daughters from different dams. The daughters of the bull will be superior to their dams. In order to conserve this superiority and stamp the whole herd with this character the breeder takes to in-breeding.

501. **In-breeding for excellence :** There is a general misconception about in-breeding or breeding by mating close relatives such as father to daughter or grand-daughter, and brother to sister. In animal husbandry, in-breeding has been the stepping-stone to the improvement of herds.

For lasting and marked improvement the foundation-stock must be sound. The original dams selected for procreation should be chosen with regard to their conformation, constitution, freedom from disease etc. Provided the foundation-stock is suitable, in-breeding by some proven bull leads to the creation of types which put the herd to a much higher level than what it was before.

We have in this country now found 10,000 lbs. milkers per lactation and more. At this stage the problem of further improvement has to be seriously considered by stock-owners. That in-breeding for excellence is a recognised practice will be clear from the following extract from the reprint of an article by Buchanan Smith, Institute of Animal Genetics, University of Edinburgh. (*Agriculture & Live-stock in India. September, 1935*)

“As a means for the improvement of live-stock, in-breeding is one of the most important weapons which a breeder can employ. First and last, the success of in-breeding depends upon the quality of the foundation-stock. This quality must be good in two respects—in respect of productivity (yield of milk and butter-fat in the case of dairy cows) and also in respect of constitution. Furthermore, the quality of the foundation-stock must be good, not merely so far as the eye can judge, but it must be absolutely sound as regards the hereditary mechanism.

“The hereditary constitution of an animal can only be judged by the stock that it produces. By mating two closely-related animals together, we can the more assuredly obtain an indication of their hereditary constitution.

“By in-breeding plus selection we can concentrate the desired qualities. This leads to prepotency.”

In our country it is necessary to fix the types of our herds, **by intelligent** and watchful in-breeding. I consider it a desirable thing for the day. There may be failures in certain issues, and the progeny in such cases should then be eliminated by making them sterile. (163)

502. Warning about in-breeding : Though in-breeding has produced excellent results in the hands of skilled breeders, the amateurs should be very careful in using it. There are chances of the undesired characters multiplying or ultimately ruining the herd. For, in-breeding fixes characters both

desirable and undesirable. In-breeding continued for a long time may result in lowered vitality or lessened fertility in the off-springs. (163)

503. Improved bulls for non-descript areas : In non-descript areas, the problem is entirely of a different nature. There the cattle are generally very poor. The impetus to the supply of improved bulls has been operating in these areas also. The Government appears to have adopted the same policy for these areas as for other areas.

A fundamental matter in the problem of improvement is environment and also fodder. In connection with the suitability of the Rojhan cattle for the poorer areas of the Punjab, it has been mentioned that environment is the determining factor. Animals unaccustomed to damp climate and poor fodder are likely to suffer and deteriorate if brought into these areas for breeding. And it is very doubtful if the progeny can survive the treatment and the unsuitable environments. (271)

504. Eastern Bengal remains four months under water : Take, for example, the case of eastern Bengal. This area remains flooded for four or five months in the year. Houses look like little islands. In such areas it is most difficult to maintain the health of the cattle during this trying period. Nothing except dry rice-straw may be available in most localities. (349)

505. Rice-straw as a single feed : In other parts of Bengal also the rainfall is very high, and except in a small tract in western Bengal, flooding during the rainy season is a common feature. Fodder is not a

cultivated crop in Bengal. The staple food ~~scraped~~ straw with what green grass may be scrapped together. Rice-straw as a single feed is a very bad material. Researches conducted on the nutritive value and digestibility of the *rice-straw* have shown that it is defective in minerals. There should be a proper ratio between calcium and phosphorus, and this is disturbed in the rice-straw. Besides, it has got too much of excess of potassium which makes calcium unassimilable. The protein it has got is not assimilable. Upon this material as the principal fodder, generations of cattle in Bengal and in other rice-tracts of India are being raised. No wonder that the cows there are so poor. Acclimatisation of generations has enabled the rice-area cattle to subsist on such poor fodder. For such areas, if improved bulls from some famous breeds are brought in to cross-breed, the result may be extremely disappointing. The few bulls from the Punjab can do nothing. They can make hardly any impression whatever upon the millions that exist in Bengal. Then again, the importation of a bull of another breed is not an end by itself. If, for example, the Hariana is allowed to mate with non-descript Bengal cows, the motive should be to gradually mate the herd wholly with the Hariana, beginning with half-breeds and ending with converting it ultimately to the pure-bred Hariana. Regulated breeding can have some such aim. The question arises—will the Hariana or any cattle of some famous breed be able to stand the Bengal environments and the treatment that a Bengal

cultivator is likely to accord and is capable of according it, considering his present circumstances? (397, 655, 794-814)

506. Danger of importing superior-type bulls : Mr. Pease enunciated a principle which should be applicable to Bengal and other rice-tract cattle in *toto*. According to him, it should be the aim to produce an animal of the same class which is found in the locality, but stronger and better and which will subsist on the available fodder. (271) Importation of heavy, large bulls of the Haryana type into such areas as Bengal goes against the above sound principle. On the fodder of the rice-tracts such bulls or their progeny cannot be expected to do the work that is being done even by the local degenerate stock. (217)

507. Olver on dangers of importation of an alien type : Sir Arthur Olver in one of his articles said :

".....That high-class stock can be produced in areas which are not naturally suitable for them, there is no question, but the cost of doing so is prohibitive for the ordinary breeder and, apart from the constant struggle against adverse circumstances which would be entailed, there is the difficulty that—if of a breed or type different from the local stock—the male progeny, when used as sires, would be likely to do more harm than good. Moreover, in order to obtain fresh blood it would be necessary constantly to import sires from elsewhere."

—(*Agriculture & Live-stock in India*. July, 1937)

The case exactly applies to the rice-area cattle. In those tracts and under the present village conditions of

living, fodder-supply and environments, the Haryana sires are not likely to be suitable. It will require a constantly increasing flow of Haryana blood to keep up the change introduced, and that it is likely "to do more harm than good."

508. Bruen's experience with superior types :

"...The first cross, resulting from a mongrel cow and a pedigree bull, is often so good as to deceive even the experienced eye, and frequently large sums are paid for such bulls in mistaking them to be pure. Their progeny, however, have thrown back to an even worse type than their degenerate mongrel dams." (*1st meeting A. H. Wing, (1933).—P. 150*)

With all these, it is a fact that the Bengal Government schemed, in the first instance, for bringing in 1,500 bulls for 15 districts of Bengal from the Punjab, necessarily of the Haryana breed, and they have been distributed to the people. (271)

509. Olver prescribed Harianas as milch-breed for Bengal : Sir Arthur Olver, in spite of his own warning as quoted above, had advocated the use of the Haryana or Rath sires for Bengal by mixing carelessly the need for city milk-supply with the need for cattle improvement in general. In speaking of the improvement of milk supply, he said, (*Agriculture & Live-Stock in India. September, 1938*) :

"In areas where the cattle are hopelessly poor and inefficient, it may even be necessary to introduce better stock from other parts of India to demonstrate to the *ryot* that good cattle, and in particular milch-cattle, are very profitable, if properly fed

and maintained, on the holding in such a way as to ensure that as little as possible of the manurial value of their urine and droppings is wasted. With a view to making rice-growers more cattle-minded, I have recommended to provinces and states within easy reach of Calcutta that they should take advantage of the opportunity of obtaining good *Hariana* cows there, at moderate prices, and hand them over to selected *ryots*, on part-payment terms, on the condition that the allottees undertake to introduce a sufficient proportion of suitable legumes or grasses into their rotation, to supplement the usual rice-straw ration. Such a system should make economical milk production possible and should enable the stock to be maintained in better condition all the year round. I have also suggested that a sufficient quantity of silage should be made for each of these cows from young grass or leguminous or other suitable crop, quantities of which can be grown during the monsoon in such areas and cut at an early stage of growth, to ensure that sufficient succulent fodder would be available during the dry season. Under departmental supervision such cows should prove a valuable source of additional income besides producing useful young bulls or bullocks and should be useful as an object-lesson not only to the allottees but to their neighbours as to the value of superior stock if properly fed. For rice tracts within easy reach of Calcutta, I have, therefore, recommended small-type, compact *Hariana* bulls, and they are doing well and proving

highly popular. In similar areas, not within easy reach of Calcutta, I have in the past recommended Tharparkar cattle, and I consider that they or, even better, good Rath cattle, should prove the most suitable. Both are very compact and hardy and good milkers and Rath cattle in particular are quick, active workers."

Sir Arthur Olver's statement is contradictory to the principle enunciated by him as quoted in a fore-going para (507). Taking the last part of his observation, we find that he recommended Hariana bulls for rice-tracts within easy reach of Calcutta, and for tracts not within easy reach of Calcutta he recommended Tharparkar and Rath bulls. (350)

510. Can Harianas thrive under Bengal village conditions ? : But what will the Tharparkar or the Rath bulls do in the interior of Bengal ? Will they be able to poodle the rice-fields and live on rations of rice-straw or, perhaps wholly on water-hyacinth during the flood-periods ? No body can say that without trial. Then again, will it be possible to "Harianise" the entire stock of Bengal ? And, who knows that even any attempt at the introduction of Hariana blood into Bengal cows will be productive of improvement and not do harm, as Olver apprehended, and as Bruen denounced ? This can only be ascertained by breeding up to four generations in Government farms. Unless this is done it is unsafe and wrong to pass on Hariana bulls to the interior of Bengal, Orissa and other wet and rice-tracts. Even if in the limited scope of Government dairy farms, crosses come out successful,

yet till the fodder-supply is improved it would be disastrous to import blood from other provincial breeds, where the peculiar fodder conditions of the rice-tracts do not exist. Olver had qualified his recommendation of the introduction of the *Hariana* by ensuring the production of better fodder simultaneously. Even, according to his recommendation, one cannot go without the other part—the part of the introduction of legumes and silage etc.

511. Pure-bred *Harianas*—a necessity in Bengal for milk : The first part of Olver's recommendation of *Hariana* cows is for those areas where the cattle are hopelessly poor and inefficient as in the provinces within easy reach of Calcutta. Probably he meant Bengal, Assam and Orissa.

According to the context this is for improving the milk-yield. A dairy cow confined to dairy purpose is a necessity for the towns only. For example, take Calcutta. To meet the milk-need of the city *Hariana* cows are brought in annually and slaughtered after they have finished that lactation. At Calcutta under the special protective provisions provided in the city suburbs and the care that the *Gowalas* take, *Harianas* and *Sahiwal*s thrive. It is not only feasible but a necessary proposition for cities like Calcutta and also for interior towns to have high-milking breeds, and stall-feed them. In order to save the thousands of good milkers imported from the Punjab annually from slaughter, it is imperative that the pure-bred *Hariana*, or better, the *Sahiwal* herds, should be built up in the neighbourhood of Calcutta and other cities and

towns even in the wet-and-rice-areas of poor cattle. It is wholly a question of supply for the towns. The bull calves that will grow up from such maintenance of the pure Hariana or Sahiwal herds will not be fully required for dairy purposes in these city-supply herds. They may be sold to be reared in the U. P. and Bihar where conditions are not so bad as in Bengal. If the surplus Hariana and Sahiwal bull calves are passed on to the Bengal cultivators, even free, without a change of environment, it will mean undertaking a large-scale experiment the result of which may be disastrous. •

Already over 2,500 bulls of the Hariana breed have been scattered over Bengal. It is time to wait and see how the progeny of these bulls thrive under the village environments and the village feeding of Bengal. From private correspondence it has been ascertained that the I. C. A. R. is not in a position to pronounce an opinion upon the success or otherwise of the Hariana bulls distributed in the wet-areas under Lord Linlithgow's gift-bull scheme. (350)

512. Mass-scale crossing undesirable : It has been reported of a farm in Bengal where Hariana bulls were used for the usual Bengal village cattle, that the result has not been satisfactory, and the deterioration has been fast. The herd was virtually broken up. Details have to be obtained of this trial. I had occasion to see some of the Bengal-Hariana crosses. They gave only 3 seers of milk under the best feeding conditions. As much milk and more may be obtained from some local cows under careful management. Judging from

this, the crossing of the Haryana with the mongrel or non-descripts of Bengal and other rice-tracts seems to have little future for mass utilisation.

The real step towards improvement in the poor wet and rice tracts is first to improve fodder and disseminate a knowledge of the deficiency, and the means of correction of the deficiency of rice-straw as a fodder. When this is corrected the poor cattle will undoubtedly show much better form. Then, by selection and in-breeding good types may be founded and spread all over the provinces by careful line-breeding. Experiments of crossing with bulls from the Punjab or Sind should be confined to Government institutions and farms.

For dairy purposes for the town-supply in these poor areas pure-bred herds of Haryana or better the Sahiwal should be established, and the surplus bull calves produced should be disposed of, as already mentioned, for rearing into sires for the other drier provinces where there is a need for them.

513. Castration of scrub bulls : Scrub bulls, be they in areas having definite breeds or in non-descript cattle-areas, should be castrated. In Bengal bulls are found to be yoked. As the bulls are of poor quality the cultivator does not feel any difficulty in yoking them to the plough and using them like bullocks for cultivation. These bulls, used for draught purposes, of course, do serve as sires to the herds. This practice is highly injurious, and leads to certain deterioration of the cattle. If the deterioration is to be stopped these bulls should be castrated. Here

Government might step in with legislation. But prior to its enactment, popular opinion should be created by educative propaganda. Mere legislation in such a matter will be useless, unless it be preceded by intelligent educative propaganda and also a large measure of persuasive castration in selected areas. Simultaneously with this, a sufficient number of approved bulls will have to be supplied. In areas with well-known breeds the matter of bull-supply will not be so difficult. In areas of non-descript cattle, local bulls of a better type must be bred, since the introduction of bulls of known breed from other provinces is not recommended. Castration of scrub must go side by side with the rearing of better bulls. Bulls should not be castrated without making adequate arrangements for the supply of improved ones. The problem is of vast magnitude. The process of castration should be begun extensively and immediately. The problem of the supply of better bulls from village herds should be simultaneously taken up earnestly to stop the deterioration of the cow.

There are some attempts by the Provincial Governments to castrate. The number castrated is, however, insignificant. The demand for castration is for all the male-calves that are born in the year except those that are to be reared as bull calves. In addition to this, the stray scrub bulls and bulls yoked to plough have to be castrated. (480)

514. Licensing of bulls is a forward step : It is a good legislation to require every owner of a bull or of any male calf to have it licensed on the second

year of its birth. The necessary staff and organisation is wanting on the part of the Government.

But where Government is delaying or unable to cope with the problem, the village communities can for themselves take up this work. It is quite easy to castrate with a modern pincer castrator. They may be made in India and sold cheap instead of using the imported ones. Burdizzo castrator comes from Italy. Every village may possess a castrator and get the operation performed quickly and painlessly on the male calves during the second year after birth or before, according to local practice, excepting those calves that are to be reared as bulls. The village community may receive gifts of approved bull-calves or buy them, the best available in the locality, for rearing as stud bulls.

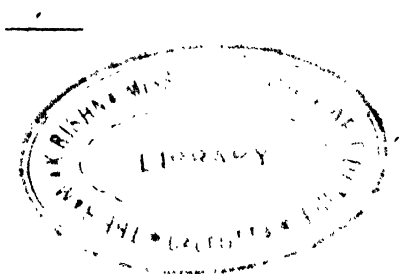
515. The Bombay Act : The Bombay Government passed an enactment for castration and subsequently made rules for carrying on the work of compulsory castration. The enactment of law, of course, presupposes licensing. A village community as an organised unit can achieve the same object by voluntary co-operation and watching. No expenses are involved. If the cow has to be saved, disciplined and co-operative action is absolutely necessary from within. The cattle of India rose to their greatness because such a protective and progress-ensuring machinery was in existence within the village and in its social structure. These have to be rebuilt according to the necessity of the present times and suitable to the existing conditions.

516. The Madras Act: The Veterinary Department Report of Madras (1940-'41) mentioned that—
“...The breeding of cattle has in recent years suffered a check owing to the progressive reduction in the supply of fodder consequent on the replacement of cereal crops by other commercial crops, e.g., cotton, tobacco, chillies, turmeric, etc., which yield no fodder. The decrease in the total cultivated area during the quinquennium ending in 1935 is estimated at 0·8 million acres. The quality of cattle has also suffered owing to the great dearth of good bulls in the breeding tracts... proportion of breeding bulls to the number of cows in the Nellore and Guntur districts (both forming the Ongole breeding area) was 1 : 231 and 1 : 122 respectively while the proportion for the whole Province was 1 : 20 cows. Vigorous attempts are now being made to augment the supply of breeding bulls for these areas by encouraging the maintenance of bulls in the breeding tracts with financial aid from Government. To this end, schemes have been drawn up..... The bill to enforce compulsory castration of bulls, not suitable for breeding purposes, was passed by Government during the year as the Live-stock Improvement Act, 1940.”

517. Grading of village cattle (Madras): The Madras Veterinary Report of 1941-'42 referred to the grading of village cattle. It advocated the 'grading' of village herds which was regarded as the cheapest and easiest method of obtaining rapid results.

"...It has been computed that in about six generations the unimproved blood almost disappears in the common village cattle by the continued use of pure-bred sires. An important point, however, is that the good effect of grading ceases the moment a pure-bred bull is withdrawn from the locality. If the cattle of the district are to be improved, it is very essential that the graded cattle are all sired by an unrelated pure-bred sire of the same breed as the previous sire. ...Government (Madras) agreed with the Board and directed that graded cattle should not be sired by half-bred bulls and that the Veterinary Department should make a start in the grading of village cattle..."

It appears that the Veterinary Department of Madras have taken steps to see that the progeny of improved sires are not served except by a pure-bred unrelated bull of the breed of the sires. For this purpose a register of all cows served by each bull will be maintained by the staff.



CHAPTER XIII

MARKETING—MELAS, FAIRS, SHOWS

518. **Marketing of animal products :** The marketing of animal products, and more directly the marketing of milk-products, seriously affect the cow and may be directed towards improvement of the cow and of saving her. The influence of a good market affects the cows immediately and directly. The price of milk is high in the cities and lower and lower in the interior according to the distance of the place from prominent centres of business. There are localities where cows give some milk in particular seasons, and it may happen that in that season there is little demand for it. The cultivator thinks of what he uses in the family in terms of waste, because he wants ready money for his milk. The local *gowala* takes advantage of the cultivator's disposition and also of his need, and keeps the price below the fair level. The cultivator seeing the little return that the cow brings from milk neglects to feed her. If some cash had come to him from the milk, he would take good care in feeding the cow. As soon as the milk in the country-side becomes remunerative, the condition of the cow improves and she is placed on the road to giving more milk.

Where there is active and competitive trade in milk or milk-products from the cow, where the

buffalo has not stepped in, the cow begins to thrive at least during the milking season.

519. Competition between cows and buffaloes for the market : The cultivator can only undertake to feed the cow when he finds that what he puts in for the cow will come back to him in return. This last stand of the cow is being taken away by unfair competition from the buffalo. Both in the liquid milk market and in the *ghee* market, the cow is being pushed down. The reasons have been already discussed. It is for the village communities to save their cows from the competition of the buffalo. The assessment of milk on its fat-content only is the original source of mischief. Co-operative action which will lead to the better valuation of cow-milk can rectify this, coupled with legislation against adulteration of buffalo-milk and passing it off as cow-milk. But the place of intelligent understanding is much greater than that of legislation in this matter. Cow-milk can stand against buffalo-milk on its own merits. In the case of liquid milk the unfair competition begins with the watering of buffalo-milk and with the passing off of that as cow-milk. In case of milk products, particularly of *ghee*, the unfair competition comes in with the depreciation of the skimmed milk or curd (*lassi*) left after extraction of the fat, and also in evaluating all *ghee* as *ghee* and not on its nutritional value. (109-'27)

520. Cow-ghee contains 'ten times carotene vitamin : A decisive factor in favour of cow-*ghee* is that it is superior to buffalo-*ghee* as a nutrient.

Besides fat, *ghee* has the most valuable constituent Vitamin A. It has been proved also that carotene, a colouring material, is the precursor of Vitamin A., and is really a Vitamin A. substitute. The difference between cow and buffalo-*ghee* lies in their carotene and vitamin-contents. Cow-*ghee* contains ten times the carotene of buffalo-*ghee*. Cow-*ghee* has 20.9 I. V. units carotene per grain against 1.9 units of the buffalo. —(Majumdar).

In a paper on the carotene-content of cow and buffalo butter fat by Bal it is claimed that while the carotene content of buffalo butter fat is between 20 and 30 micrograms in 100 grams, that of cow butter fat is between 200 and 570 micrograms. (Bal and Shrivastava. *Nagpur University Journal*, 1940, No. 6)

"Cow-*ghee* is superior to buffalo-*ghee* in regard to the stability of its Vitamin A. towards heat." (Banerjee. *Agriculture & Live-stock in India*. January, 1937). The little vitamin that the buffalo-*ghee* has suffers worse under heat.

Ghee has to be heated for cooking. On heating, buffalo-*ghee* loses more Vitamin A. than does cow-*ghee*. It has been found also that the presence of carotene works as a preservative, preventing destruction and oxidation of the *ghee* by storage (Banerjee. *Agriculture & Live-stock in India*. March, 1938), and buffalo-*ghee* has been found to have hardly any carotene (Majumdar).

It will thus be seen that on all scores cow-*ghee* comes out many times superior to buffalo-*ghee*.

Therefore, the two products, cow and buffalo-*ghee*, should be valued separately by the consumer and the seller. All these are reasons of health for which cow-*ghee* should be preferred to buffalo-*ghee* and cow-milk to buffalo-milk. The other and the most overweighing point has already been considered regarding the future of the cultivator, if he should continue to neglect the cow and give preference to the buffalo. It has already been shown that the cultivator will be able to produce both *ghee* and milk cheaper from a well-nourished cow than from a buffalo.

In their own interests the cultivator-breeders should give preference to the cow in the milk and *ghee* market, and the consumer also should give preference to cow-products. (127, 377)

521. Better marketing for cow-products : Better marketing facilities for cow-milk and cow-*ghee* will secure the premium that is due to the cow. Today there is little preference for cow-*ghee* ; in most places the two milks are mixed and a mixed *ghee* marketed. In their own interest the *ghee* merchants may volunteer to pay more for the *ghee* made from the milk collected separately from the cow alone. The mixed *ghee* will then disappear, and the cow-*ghee* and buffalo-*ghee* will remain till buffalo-rearing ceases altogether.

If the cultivators are alive to their own ultimate good, they should cease to give special preference to the buffalo. Enterprising traders may greatly help the situation by stepping in and putting a premium upon cow-milk and cow-milk products. (127)

522. Effect of the opening of ghee-markets : Amongst the various points that need to be attended to for saving the cow, the one need is to save her from the unfair *competition of the buffalo*. This problem comes up seriously again and again. If the cow has to be saved she is to be the animal of preference, as she rightly deserves to be, compared with the buffalo.

The opening of the *ghee*-market in towns and the extra emphasis put on the fat of milk is a creation of the modern times. In villages there was need for *ghee* as a preserved milk-product, but *lassi* and butter-milk had also their place. In the unilateral demand from towns for *ghee*, where milk and other milk-products cannot be easily transported, *ghee* has acquired quite an exaggerated importance. The towns have created many evils, and the exaggerated emphasis on one milk-product, *ghee*, is one of those evils. Because the towns must largely consume *ghee* only, on account of the dearth of milk, *ghee* has become the one commodity to the milk-producers and dealers in villages. And because buffalo-milk contains more fat, it has been given an importance which it does not deserve. But this demand for *ghee* should not lift the stock-keepers in villages off their feet, as it has done today. They should know that they cannot keep two animals, the cow and the buffalo. Without the cow, his ploughing and other draught-work will be at a stand still. It behoves him to foster the cow, feed her well and get satisfied with what she can give. Modern dairy farms have clearly shown that both in milk-yield and in fat-production, a good cow is more

economical than a buffalo. It is all the more reason, therefore, why the cultivator should make it a point of honour to accord the best treatment to his cow and do more for her than what he does for the buffalo, and remain satisfied with the monetary income the cow brings him without hankering after the buffalo. If he will save the cow, ultimately the cow only will save him, not the buffalo. He must understand that by caring more for the buffalo and neglecting the cow, by placing an exaggerated value on the apparent money-income from *ghee*, he is undermining the animal that can save him. (127)

523. More emphasis on liquid milk : Those who can do without *ghee* should do so and rely on the milk. If the *ghee*-trade will shrink, the undue importance on the fat-content alone of the milk will cease to be, and milk for milk, cow-milk even at higher cost is better than buffalo-milk.

The fat of the *cow-ghee* is superior. This has been scientifically proved. Seeing that emphasis on *ghee* itself brings an undeserved premium on buffalo-*ghee*, irrespective of its vitamin value, a lover of the cow should not only make it a point to take cow-products only, but should limit the use of *ghee* to the minimum, for setting an example of a good practice, leading to the saving of the cow. (127)

524. Harm in fixing cow-milk fat-content too low : The *standardisation of milk* by some Municipalities and Provincial Health Departments, on the basis of the fat-content of the British cow, has deteriorated the situation. The Indian cow-milk has

rarely less than 4·5 per cent of fat while British cows give 3·5 per cent fat only. The Health Departments are satisfied in India with the 3·5 per cent fat only. It becomes possible for buffalo-milk to be mixed with a larger share of water and brought down to the standard. This also inflates the illegal gain of the traders who adulterate milk and pass toned-down buffalo-milk as pure cow-milk. The subject is further considered in connection with Dairy Practices.

Where legislation fails, trade enterprise often leads the way. It would be for the future enterprising dealers to spot out favourable localities, give premium to the keeper of cows, on condition that they cease to breed buffaloes and undertake to supply cow-milk only, by offering higher price for that. The organisation should start with the village producer. There may be adulteration and passing off of dilute buffalo-milk as cow-milk, more specially because of the premium. The work, therefore, must begin with the cow-keeper as the basis. Only those who have no buffaloes should be enlisted. Milk so collected may be separated in the village and made into *ghee*, the separated milk returning to the supplier of milk or sold as *dahi* or other milk-products such as *kshir* and *khóa*. If the villages can consume their own *ghee*, it should be sold there, the surplus only coming to towns where there is always an unsatisfied demand for genuine *ghee*. (127)

525. Village community and milk : In dealing with milk, the first consideration for the village community should be, to allow that much of milk to go

out of the village that can be done, consistently with the health of the village itself. Those who can afford, amongst the villagers, should drink more milk and should not sell off the milk so exhaustingly as has been revealed by the "Seven Tracts Enquiry."

Using more milk by the producer himself in his family, will mean less money income. But the habit of drinking milk will be a great saviour to him in the form of preservation of health and insurance against disease. This subject of the *utility of milk* and its necessity for preservation of health and ensuring of growth is dealt with in connection with Dairying.

Marketing of cow-milk at a premium rate will reflect itself in the better keeping of the cow, and will consequently lead to greater milk flow and probably milk consumption within the village, making the villages healthier and livelier. What has so often been observed about the use of *milk in schools*, will, without fail be observable in villages under the newer condition. In schools and in boarding houses attached to schools, it has been invariably observed that those children that get a share of milk grow more quickly and shed their docility and become difficult of management. Village life today is too full of docility. (399-411)

526. The effect of "drink more cow's milk" drive on cow-saving : It has been seen that milk forms a very small item in the average diet of the Indian. The result is malnutrition, lack of stamina and the high percentage of mortality. Effective propaganda on "drink more cow's milk", coupled with

cheap milk production, will go a long way towards correcting these defects. The apathy towards cow's milk in many parts of the country, especially in Kathiawar, Gujarat, Bombay, Deccan, Berar, C.P. etc., is well-known. The she-buffalo has completely thrown the milking cow into the shade. The cow starves and produces a progeny of inferior quality. Degradation in the cow has set in. The cow can produce cheaper milk, and the cow's milk is more nourishing than that of the she-buffalo. If the people take to cow's milk only, not only the condition of the cow will be improved but stronger and well-built bullocks will be made available. The cow will be permanently saved. Recent experiences gained at Wardha (C. P.) are encouraging. As late as 1925 it was very difficult to purchase even a small amount of cow's milk. But the "Goseva Vrata" has brought about a good change. A number of well-managed dairies and cattle-breeding farms has sprung up producing about 1,500 lbs. of cows' milk daily. All this milk comes from the cows that were not cared for before. A market for better type of cows has been created, and on the whole the people are becoming more cow-minded.

527. More milk for villagers : The introduction of milk diet will bring life and vigour to the villager which will be bound to be reflected on their general welfare, making them more industrious and thrifty and enterprising. The village communities will be more lively. Sports and games will re-appear, and money spent for the doubtful nostrums of village doctors will be diverted to creative work. People

will become more cattle-minded and, therefore, their own-welfare-minded.

Marketing facilities need not stop with milk and milk products. Proper marketing will mean giving proper value to the hide and also to the carcass.

Within the villages, tanneries may spring up, utilising the hide obtained from the dead cattle of the village. The *meat and bone* of carcasses will, with re-organised village life, begin to be regarded as very valuable products. They are so valuable that these bones travel hundreds of miles by boat and rail to towns and there get crushed, and then travel thousands of miles to enrich foreign soil. To the extent they enrich foreign soil, to the same extent the home soil gets poorer.

528. Cow-centered all-round village activity : With marketing opened for animal husbandry products, buyers will be found in the village itself to buy the sterile meat and bones for manuring. *Bones* charred and powdered will go to enrich the *cattle feed*, and in rice-tracts correct the most crying deficiency of the vital minerals in rice-straw.

A local tannery brought into existence for the utilisation of the hide will put a premium on *babul* bark for tanning purposes and increase the value of the *babul* tree and encourage its plantation for fuel and fodder. Previously, in many villages the villagers used to get their leather sandals and thongs and other leather goods free in return for the hides of dead cattle. The same practice may revive to the mutual benefit of both the cultivator and the tanner and the

shoe-maker. Better marketing also includes marketing of the cattle, their buying and selling. There are cattle markets throughout the country. Better marketing facilities, combined with herd-registration, will activate animal breeding and help to fetch better values for really better cattle. (24, 26, 399-412, 544, 579)

529. Markets, melas and fairs : These are the traditional places for fostering trade and industry. These are now neglected so far as the cattle are concerned. *Melas*, ordinarily, have become show places for shoddy, cheap, useless and deceptive imported wares. They do not give life ; they exhaust the life stream of the villages. With awakened interest the cattle enclosure in cattle *melas* will be the primary source of attraction. Fairs draw crowds by various questionable means. Entertainments of inferior grade are provided to draw men. Sometimes the organisers or proprietors stoop down to immorality. Nothing can be more edifying and enlivening to village life than to make the *melas* and fairs attractive by the exhibition and purchase and sale of the better cattle from better cows, better bullocks and better sires and better male-calves. Cattle-based sports may enliven when mere purchase and sale get dull. Cattle processions, milk recording, exhibition of feats of strength by cart bullocks and plough bullocks, skill in furrowing parallel and true, all these and more have endless features of attraction which can be tapped to provide enjoyment and make people cattle-minded.

530. Stone-dragging sport at Mahanandi : Here is an example from Madras. The Kurnool District

in Madras is rocky and has black cotton soil requiring heavy animals for agricultural purposes. The Ongole is the main breed, though many non-descript cattle are used. People want powerful bullocks and, therefore, judge their capacity by making them pull massive stones. This practice has given rise to sports. Animals are trained for stone-dragging and are entered for competition on festive occasions. Mahanandi is a



Fig. 36. The sport of stone-dragging at Mahanandi, Kurnool District.

(Indian Farming., Vol. II, No. 4)

place of pilgrimage, and the *Sivaratri* festival is an attraction. A committee of cattle-minded enthusiasts have been holding a Cattle Show and a stone-dragging competition here. A gold medal worth one sovereign is the prize for the winning pair, given by the Trustees of the Mahanandeswar Temple at Mahanandi.

The stone is 11 ft. long and weighs 3·2 tons. The longest distance carried in half an hour is the measure for the prize. In 1939 the longest distance covered was 211 feet. It affords sport as well as a test to the cultivators.

In every tract there are some festive occasions centering round the cow. Enthusiasts and cow-lovers may put life into these festivals, participate in them



Fig. 37. The sport of stone-dragging at Mahanandi, Kurnool District.

(Indian Farming., Vol. II, No. 4)

and make them occasions for spreading the knowledge of the importance of the cow to Indian life and of demonstrating the love for their cow.

531. Utilisation of melas for the spread of knowledge: Talks, lectures, shows, pictures, models may all go to make the places educative. Now-a-days cheap town-attractions find their way there. Cow-lovers

may transform these into places of enlightened marketing and of acquisition of knowledge about cattle, about their diseases and protection therefrom.

The *melas* and fairs are generally places of income. Cow-lovers may endeavour to spend such incomes for the improvement of the cow. The utilisation of markets, fairs and *melas* on the above lines will also contribute substantially towards saving the cow. Local *Pinjarapole* Societies and bodies like the Humanitarian Society of Bombay may form the nucleus of such improvement activities. But cow-lovers will find ample work in these congregations to organise and educate and shape public opinion for the betterment of the cow.

532. Exposure of cruelty to the cow : A lot of cruelty is practised on the cow. The use of *iron-pointed goads* has been already referred to. There are other practices. The tying on the horns and on the ears is a painful practice that should be given up. The injuries inflicted may be made objects of exhibition.

New and better yokes are being designed in place of the old ones. The exhibition of similar devices for relieving pain may create centres of attraction and education in the *melas*.

A hospital and dispensary with charts may form a feature of the *melas*. Pre-arranged lectures on the prevention of diseases and on the best way of receiving veterinary aid may be given. The cow *versus* buffalo position may be discussed, and ways and means indicated for practically achieving the object of saving

the cow. The importance of skimmed milk and *lassi* and their nutritional value may be brought out.

533. Theatricals centering round cow-life : Theatricals centering round cow-life may be organised and staged. Amusements may take the form of showing the better way of cow-treatment interspersed with stories. The country has play-writers and artists enough. Their sympathy is to be drawn to



Fig. 38. Photos from Cattle Show.
Bullocks intended for sale.

(Indian Farming., Vol. IV, No. 5)

this. Let cow-life and cow-lore be enlivened by the best that the foster-child of the cow, man, can do for her. There will be place for the author, the poet, the play-wright, the artist and the scientist in this creative endeavour.

The magic-lantern may step in, showing micro-photograph slides of clean and unclean milk, showing disease germs that travel from the milkers' hands

and communicate nastities, showing the bacteria that causes contagious abortion and renders so many cows sterile. There is no end to such educative themes.

534. Cattle Shows : The All-India Cattle Show has now come to stay. It is growing more and more important in the sense that it is drawing more and more attention to the problem of the cow. It is



Fig. 39. Photos from Cattle Show.

Visitors interested in an animal.

(Indian Farming., Vol. IV, No. 5)

helping the topmen in offices and in society to be a little more cattle-minded.

535. The All-India Cattle Show Society : The first All-India Cattle Show was held at New Delhi in 1938. It was in the nature of an experiment. It attracted 488 cattle and buffaloes. The Government organised the Show and then voted a sum of 2½ lakhs of rupees to put the Show on a permanent basis.

The All-India Cattle Show Society, as a permanent body, was registered under the Societies Act in 1939.

The second Show, held in February 1939 in New Delhi, was more successful than the first in its cattle exhibits. The number of entries was 637, including 22 breeds. The highest single entry was from the Sahiwal, of which there were 103 entries. Rs. 15,000 worth of sales were made or contracted for at this

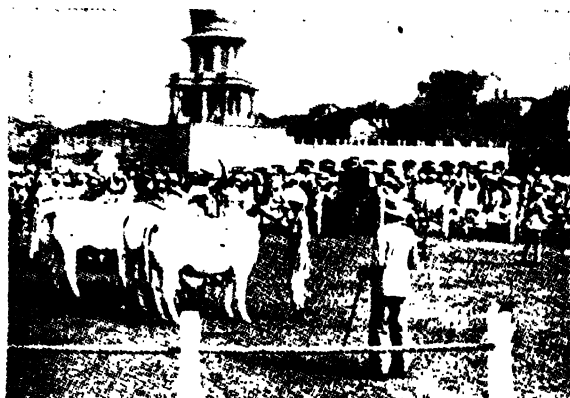


Fig. 40. Photos from Cattle Show.

Judging in progress at Bhavnagar.

(Indian Farming., Vol. III, No. 3)

Show. It should be remembered that this was a Show and not a *mela* where cattle are brought for sale. In this Show every animal brought in had to be registered first. The exhibitors had not to pay any entry-fees. All the expenses including the feeding expenses during the period of the Show was borne by the Government. Government farm

animals predominated at the Show. Government aided the cultivators to bring their cattle over long distances.

536. Central and regional Shows : The question of attracting more of the cultivators' stock engaged the attention of the organisers. It was proposed to hold regional Shows at which people of the neighbourhood



Fig. 41. Photos from Cattle Show.
Milking competition at Bhavnagar.
(Indian Farming., Vol. III, No. 3)

might participate. Two subsidiary or regional Shows have now been arranged—one, the southern regional Show at Bangalore, and the other, the western regional Show at Bhavnagar. The prize-winners at these Shows are encouraged to join the Central Show at Delhi.

TABLE-33

In 1941-'42 the Shows had the following entries :

	Cattle	Buffalo	Sheep	Goat
Bhavnagar	362	108	80	40
Bangalore	659	41	350	...
Delhi	560	150	144	113
Total	1,581	299	574	153

At these Shows the animals are classified according to breeds and types. Thus it becomes a great educational and interesting field of study for the student who can afford to attend such Shows.

537. **Shows in the provinces :** A statement on the places where breeds were exhibited was prepared for the A. H. W. meeting, 4th session, 1940, by Mr. Kartha. The list gave the places where each breed was exhibited. It is to be noted that the Tharparkar was not found in any exhibition. The Sindhi, which has the largest export market, was not exhibited in Sind.

List giving the breeds and the places where they were exhibited.

Breed.	Province.	Locality.
Ongole	Madras	Guntur, Nellore, Cuddapah, Proddatur, Jaminalamadugu, Kurnol, Mahanandi, Kurnol Allagadda, Kurnol Lower Ahobilam.
	Cochin	Chittur.
Alambadi	Madras	Cuddapah, Proddatur.
Krishnagiri	„	South Kauara, Suthanadi.

Breed.	Province.	Locality.
Sindhi	Madras	Coimbatore, Valparai.
	Bombay	Wambori.
	Bengal	Baraset.
	N.W.F.P.	Haripur, Kohat,
	Cochin	Nallipilli, Chittur.
Krishna Valley	Bombay	Ydrad, Bijapori, Athanai, Sevadi, Dharwar, Yadur, Nandi, Barwad, Belgaum, Sholapur.
Khillari	Bombay	Ydrad, Bijapori, Athanai, Gungal, Yadur, Nandi, Barwad, Belgaum, Parner, Miri, Wambori, Erandgaon, Jamkhed, Ahilyapur, Sholapur, Malsiras, Patkha l Barhmanpuri, Tandulwadi, Khatgun, Mhaswad Shingnapur, Khillari.
Amrit Mahal	Bombay	Bijapur, Rattihali, Devargudd, Gungal, Belgaum.
	Mysore	Hassan, French Rocks, Arasikere. Krishnarajanagar Arkalgud, Saligrama, Chanerayapatna, Tumkur Sira, Turuvekere, Hiriya, Harihar, Shimoga, Sorab Channagiri, Honnali. Kalasa.
	Cochin	Chittur.
Kankrej	Bombay	Sanand, Erandgaon, Akalkuva, Khapar, Patti Taloda.
	Baroda	Kadi, Pattan, Chanasma, Vadnagar Sidhpur.
Surati	Bombay	Sanand, Shri Gonda, Miri, Akola, Jamkhed.

Breed.	Province.	Locality.
Gir	Bombay	Belgaum, Miri, Wambori, Erandgaon, Akola, Sholapur.
	Baroda	Amreli, Kodinar.
Nimari	Bombay	Jamkhed.
	C. P.	Singaji.
Malvi	Bombay	Akkalkuva, Khapar, Pati, Taloda, Ahilyapur.
	C. P.	Garhakota, Burman, Singaji.
	Bhopal	Chiklod.
Siri	Bengal	Kalimpong, Kurseong.
Sahiwal	Bengal	Suri.
	Punjab	Kangra District, Ferozepur, Montgomery, Dipalpur, Kabir, Lyallpur, Chak No. 45 L. B., Bachrianwala, Chak 528 G. B., Pauliani.
	Bihar	Sonepur (Saran).
	N.W.F.P.	Kohat.
	Orissa	Cuttack.
Hariana	U. P.	Bateshwar, Mankapur, Deoroa, Ain Dhaighat, Khatauli, Aligarh, Bulandshahar.
	Punjab	Mangali, Sasai, Toshani, Dhangar, Odhan, Sonapat, Rohtak, Palla, Tigoon, Palwal, Dharuhera, Pahewa, Kaithal, Sambalka, Thaska Miranji, Gopal, Mochan, Sawara, Morinda, Hoshiarpur, Jullundur, Ferozepur, Amritsar, Gurdaspur, Sheikhpura, Sargodha, Gujrat, Montgomery, Kabir, Dipalpur, Jhang, Multan, Mailsi, Qadirpur, Kabirwala, Sakhipur, Lyallpur, Chak No. 45 L. B., Bachrianwala, Chak 528 G. B., Pauliani.

Breed.	Province.	Locality.
	Bihar	Sonepur (Saran).
	Orissa	Khirda, Briboi, Cuttack, Luchapara, Ichhapur.
Dhanni	Punjab	Jatli, Gujarkhan, Rawalpindi, Fatehganj, Tallaganj, Pindigheb, Lawa, Tamman, Hassanabdal, Mianwali, Musakhel, Sargodha, Khushab, Bhalwal, Bhagatanwala, Sullanwalli, Shahpur, Gujrat.
	N.W.F.P.	Mardan, Haripur, Kohat, Dera-Ismail Khan.
Dazzal	Punjab	Shehr Sultan, Nawan Kot, Karor, Khanpur, Baga Sher, Talai Nurshah, Jhang, Multan, Mailsi, Qadirpur, Kabirwala, Sakhipur, Dera-Ghazi-Khan, Fazalpur, Dajal, Lalgarh, Taunsa, Sikhaniwala, Rojhan.
Gaolao	C. P.	Katol, Dhaga, Borgaon.*
Hallikar	Mysore	Bangalore, Hoskote, Kankanhalli, Chennapatna, Nelamangala, Magadi, Devanhalli, Doddballapur, Sidlaghatta, Bagewalli, Chintamani, Goribidnur, Chikballapur, Malur, Kollar, Hassan, Hunsur, T. Narasipur, Arasikere, Krishnarajnagar, Arakalgud, Saligrama, Holenarasipur, Maddur, Mallavali, Nagamangala, Channerayapatna, Tumkur, Chiknaikanhalli, Sira, Pavagada, Kunigal, Turuvekere, Madhugiri, Gubbi, Hiriya, Harihar, Shimoga, Sorab, Channagiri, Honnali, Kalasa.

* At present the Shows are held at Wardha, Ycotmal, Chandur, Katol, Umreh, Garhi and Sawner.

Breed.	Province.	Locality.
Mehwati	U. P.	Deorua.
Kherigarh	U. P.	Deorua.
Ponwar	U. P.	Chandpur, Shahjahanpur.
Kosi	U. P.	Bateshwar, Shahjahanpur.
Nagori	C. P.	Singapur.
Dangi	Bombay	Jamkhed.
Deshi	Bombay	Jamkhed.
Tapti	Bombay	Ahilyapur.
Gavati	Bombay	Islampur.
Mhaswad	Bombay	Khatgun, Khanpur.
Nepali	Bengal	Kalimpong, Kurseong.
Shahabad	Bihar	Hizla.
Taypor	Bihar	Sonepur (Saran).
Kathiware	C. P.	Garhakota.
Khurgoni	C. P.	Singapur.
Gujjamava	Mysore	Bangalore, Magadi, Nagamangola, Tumkur, Kunigal,
Nadudana	Mysore	Dodballapur.
Bettadadana	"	"
Bettadapur	"	Hunsur,
Nadu	"	Tumkur, Kunigal.
Pandharpur		
buffalo	Bombay	Belgaum.
Mehasana		
buffalo	Baroda	Kadi, Pattan
Nili buffalo	N.W.F.P.	Haripur.
Jaffarbadi		"
buffalo	Baroda	Kodanir.

538. The Score-Cards : For judging the cattle, the cows and bulls that compete in any exhibition, some method of judging their comparative merit has to be adopted. This has been accomplished by the

introduction of the Score-Card system. The object is a thorough examination of the surface of the body in comparison with the breed and type which the animal represents. Pure breeds show uniformity in physical appearance and can, therefore, score the full marks of 100 if all parts are perfectly and satisfactorily aligned.

In examination by Score-Cards some marks are put against every point or its component part in the body. The ideal points are given marks. The full marks allotted to the body total 100. The putting of marks is more or less arbitrary and no two experts may agree. Still it is something to go by. The system has come from the West and the Western or the British system of making 13 points and subdividing and assigning marks to them were more or less empirically adopted before. But now new Score-Cards are being made for every special breed and marks put against them.

But after all, despite this mechanical sort of aid, it is the discriminating eye that really counts in assigning marks to the animals and often the Score-Card system becomes a hindrance rather than an aid. It has been held in India that the Score-Cards should be better utilised in training the student to judge the important points that count for evaluating cows and bulls. This would be legitimate scope.

Below are given Score-Card models—one for the Ongole and another for the Gir, cows and bulls. The Ongole card was suggested by Capt. Littlewood of Madras and the Gir card by Mr. Kothawalla.

539. Score-Card for judging the Ongole :

Point.	Marks for cows.		Marks for bulls.
1. Head.			
Forehead	1	...	1
Face	1		1
Muzzle	2	...	2
Jaws	2	...	2
Eyes	3	...	3
Ears	1	..	1
Horns	3	...	5
	<hr/>		<hr/>
	13		15
2. Neck	2	2. Neck	5
3. Dewlap	2	3. Dewlap	2
4. Hump	2	4. Hump	4
5. Shoulders	6	5. Body	9
6. Chest	4	6. Chest	6
7. Barrel	10	7. Barrel	8
8. Loin	6	8. Loin	8
9. Rump	10	9. Rump	6
10. Tail	3	10. Pin bone	2
11. Flanks	2	11. Tail	2
12. Thighs	2	12. Flanks	2
13. Legs & feet	8	13. Thighs	5
14. Skin & Hair	5	14. Legs	6
15. Mammary system	10	15. Feet	4
16. Style & quality	7	16. Skin & hair	5
17. Size & weight	5	17. Colour	4
18. Colour	3	18. Size & weight.	5
	<hr/>		<hr/>
Total	100 .		100

—(Ongole Cows & Bulls by R. W. Littlewood)

540. Score-Cards for the Gir :

Cows.		Bulls.	
Point.	Marks.	Point.	Marks.
1. Head		1. Head	
Forehead	4	Forehead	5
Face, Muzzle	1	Face, Muzzle	2
Eyes	1	Eyes	1
Ears	4	Ears	4
Horns	3	Horns	3
	<hr/>		<hr/>
	13		15
2. Body & Limbs		1. Body & Limbs	
(i) Fore quarters		(i) Fore quarters	
Neck	2	Neck	2
Dewlap	1	Dewlap	1
Chest	3	Chest	4
Legs and Shoulder	3	Legs and Shoulder	4
(ii) Barrel		(ii) Barrel	11
Back	4		
Ribs	4		
Navel	1		
(iii) Hind Quarters		(iii) Hind Quarters	
Loins & Hips	5		28
Rump & Pin bone	6		<hr/>
Flanks	2		50
Thighs, Buttocks	4		
Tail	2		
Hocks, Legs, Hoofs	5		
	<hr/>		

Cows.		Bulls.	
Point.	Marks.	Point.	Marks.
3. Udder, Teats & Milk Veins		3. Skin, Hair Escutcheon	10
Udder	6		
Teats	5		
Milk vein	5		
	<hr/>		
	16	4. Colour and colour markings	5
4. Skin, Hair, Escutcheon :			
Skin	4		
Hair	2		
Escutcheon	2		
	<hr/>	5. General appearance, Size, Bearing, Gait, Temperament, Character and Trueness to Type	20
	8		
5. Colour and colour markings	4		
6. General Appearance, Size, Bearing, Gait, Temperament, Character, Trueness to Type :			
General appearance	4		
Size	2		
Bearing	3		
Gait	2		
Temperament	2		
Character	2		
Trueness to Type	2		
	<hr/>		
	17		
	<hr/>		
Total marks	100	Total marks	100

Suggested by Mr. Zal. R. Kothawalla.

(A bull or cow should be disqualified if it scores less than half the marks allotted to each points)

CHAPTER XIV

MIXED FARMING AND COTTAGE INDUSTRIES AS COW-SAVING MEASURES

541. Farms were invariably mixed farms: In India farmers are invariably mixed farmers. Agricultural farming consists of growing agricultural products from the soil. In England and in other countries, they use the horse or oil engines for ploughing and preparing the field for the seed. We, here in India, use the bullocks for that purpose. Every cultivator has, therefore, to keep bullocks. Most generally where bullocks are used, the farmers desire to raise the stock themselves and, therefore, keep cows both for the milk and for the supply of her male-calves as bullocks for draught purpose. Every farmer is both an agricultural farmer and an animal husbandry man and a cattle breeder. Their differentiation was non-existent in India. The *gowalas* maintained cows only for milk; but such cows in the hands of the *gowalas* who specialised in the milk trade never formed more than an insignificant part of the total number of cows in the country. It is so even now. A differentiation has been sought to be made by the Government between these functions of the cultivator. In this matter of milk production, the

more is the attempt to isolate and divide the life of the villager, the more complex and intricate becomes the problem of living a healthy village life. In the matter of milk, Government departments concerned are continually emphasising the separation of the two functions,—draught and milking. The draught animal is to be *the cow* and the milch animal *the buffalo*. This unnecessary emphasis has already done great harm. On the other hand, nothing is done to prevent buffalo-milk, watered down to a very low content of fat, from passing off as cow's milk. It is time that the Government should be alive to the disaster to which their short-sighted policy of looking upon the buffalo as the milking animal is leading the country.

542. **Cattle and agricultural farmers are not separate units:** Similarly, the distinction between an agricultural farmer and a cattle farmer has no real meaning in India. Every means should be taken to encourage mixed farming where the habit may be disappearing. Mixed farming will mean agricultural farming, and dairy farming and cattle breeding. All these should go together. By combining the two endeavours the cultivators put themselves in line with their ancestors. And their ancestors did thrive.

Every cultivator has to be a cattle farmer. Instead of putting all his land under food and money-crop he should put some under fodder and become a real cattle farmer or an animal husbandry man. Although, every farmer is potentially so, yet the modern separation of functions has begun to affect agricultural life.

For some time the I. C. A. R., particularly Sir Arthur Olver, was advocating mixed farming for securing greater income to the cultivator. The essence of this was to take off some area from grains and money crops and put that area under fodder. The extra area under fodder should be such as to carry the burden of the milch-animals maintained for dairy purpose and cattle-breeding.

543. Mixed farming necessary for more milk: In the United Kingdom they had been getting 39 ounces of milk *per capita*. In 1943 the Ministry there sanctioned an expenditure £ 3½ millions to be spent in course of the four years to increase the consumption of milk. £ 3½ millions in 4 years converted into rupees come to one and a half crore of rupees per year. And the expenditure is only for an endeavour to induce people for increasing their milk-consumption.

The need for mixed farming is great. The extra fodder will put extra milk into our weedy cows. It would not diminish the crop out-turn. More manure from better-fed and stall-fed cattle would give greater out-turn which would make up the loss for lands put under fodder. This process would secure some extra milk of which the country is so much in need. Put money value into the milk if you like, but ultimately it is nutritional value—a value which every thoughtful man would like to retain for the producers in the villages to improve their health. It will help to cheapen milk, and at the same time be profitable to the cultivator. That India needs cheap milk, that her best interests will be served by reserving any increase of milk for

the poorest is a matter of discussion in connection with the development of the dairy industry.

That more animals kept in farm will give greater out-turn of fodder and grain per acre is the experience of some observers. The following Table from the Telankhery Dairy Farm is illuminating.

TABLE—34

Serial No.	Year.	Fodder in maunds.	Grain in maunds.
1.	1932-33	12,595	219
2.	1933-34	12,694	506
3.	1934-35	18,028	350
4.	1935-36	15,143	529
5.	1936-37	18,272	634
6.	1937-38	19,024	433
7.	1938-39	19,473	610

—(*Report of the Industrial Survey Committee. Part I, Vol. II*).

544. Place of cottage industries : Cottage industries have been included as one of the means for saving the cow. When we have more and stronger cattle the question will be—what do we propose to do with them as we refuse to eat them? The only reply is to utilize them for what they are worth. The females will be utilised for giving milk, and the males, over and above one bull per 50 cows, will go to be employed in work.

Work for them is there, in the matter of carting, water lifting, oil-pressing, sugar-cane-pressing and the driving of cottage machineries coupled to gear.

A great deal of all that is turned out in factories could be turned out nicely in villages by the introduction of bullock power. There is no scientific spirit in allowing man power and animal power to run to waste on the one hand, and in going after oil-or-coal-driven engines on the other hand. There should not be this under-valuation of living engines. Cottage industries are intimately connected with village-centered life, not based on exploitation. There can be exploitation in it also, but the opportunities are less and the checks are very much greater.

Production of more fodder and larger quantities of stall-manure, and consequent increase in the yield of crops ; more food and more milk for the people—these are the prospects of mixed farming and ultimately of the employment of more cattle-power and more man-power for creative work. (24, 26, 412, 528, 579)

545. Economics of mixed farming : Sir Arthur Olver gave a rosy picture of the future when India would become cattle-conscious. He was not petulant and angry with the weedy cows. This article was entitled "Potentialities of Dairying & Mixed Farming in India." (*Agriculture & Live-stock in India. July, 1934*)

".....From the result obtained in this (Ferozepur) herd it is clear, however, that the best Indian cows can compare very favourably with dairy herds in Europe and America, both in *milk-yield* and in *butter-fat production*."

"...the possibilities of improving Indian cows are much greater, owing to the general lack of

attention which has been paid to milk-yield among Indian cows in the past, due largely to concentration on the breeding of work-cattle, and to a general preference for *buffalo-milk*—for *ghee* production owing to its very high content of butter-fat.”

“Another important aspect of the development of the huge dairy industry of India, at the present juncture, is the relief mixed farming, including the rearing of a due proportion of live-stock, could give to the market for cereals and other agricultural cash crops. Even a slight increase in the consumption of dairy products would enable large quantities of grain, not necessarily of the best quality, to be taken off the market and satisfactorily employed in the feeding of dairy cattle. It is, in fact, calculated that a 10 per cent increase in the consumption of dairy products, throughout India, would entail an increase in the consumption of concentrates equivalent to the total average export of grain of all kinds, during the past three years...”

546. Change of outlook needed: In Sir Arthur Olver's thoughts dairy meant a cow-dairy and not a buffalo-dairy. From whichever angle we look at the problem of poverty of the Indian cultivator, imposed upon them with the introduction of British rule, the starving of men and cows that has become so common, may disappear only if an attitude of mind is cultivated for caring for essentials, for things of food and clothing first, and for money to purchase luxuries or even other necessities afterwards. Sir Arthur Olver suggested in the article to Indians to stop the export

of grains, and feed these grains as concentrates to the cattle and get milk in return. His suggestion, if worked out, will bring us to the position that by mixed farming more milk is obtained. The loss of cash-money on account of the stoppage of export can be more than made up from the sale-proceeds of better animals that such a change in feeding cattle would bring about.

547. Robbing of the soil : But Olver's thoughts or those of men like him did not count in the administration of the country. If this suggestion had been put before the Linlithgow Commission, and similar ones were actually put, it would have worked them up to raptures over the beauties of exporting fodder and manure and the consequent deprivation of the Indian animal and the Indian soil of their food. For, according to the Royal Commission, it is only out of concern for the future of the cultivators that such a robbing of the soil and of animal-food must go on. Here is what the Royal Commission opined on the suggestion of the *stoppage of export* of oil-cakes, oil-seeds, bone and bone-meals etc.

The Report began the subject with a mention of the loss to the Indian soil by the export of oil-seeds etc., and ended by saying that this drain must continue for the welfare of the poor Indian cultivator. The same was said about the export of oil-cakes, of the export of fish manures and of bone manures. (27-29,479)

548. Export of oil-cakes supported by R. C. :

"The loss to India of a valuable source of combined

nitrogen as the result of the export of so large a proportion of its production of oil-seeds was emphasised by many witnesses before us. The yield and exports of oil-seeds during the *last fifteen years* are shown in the following Table :

TABLE—35

Export of oil seeds.

Total of 15 years—1911 to 1925

	Total yield (‘000 tons)	Total export (‘000 tons)	Percentage of exports to yield
Cotton seed (1)	27,697	2,198	8
Ground nut (2)	14,019	2,842	20
Rape & mustard (3)	17,093	2,825	16½
Linseed (4)	6,915	4,642	67
Sesamum (5)	6,794	779	11½
Total of (1-5)	72,518	13,286	18
Total of all oil seeds	not available	15,356	...

“These figures indicate that, of the out-turn of the seed of cotton, ground nut, rape and mustard, linseed and sesamum, the exports amount to an average of 18 per cent, and they suggest the loss which the soil of India suffers by the export of a valuable by-product, on the assumption that the whole of the nitrogen contained might be returned to the soil. Under existing practice, indeed, much of this material would probably be fed to cattle and subsequently dissipated as fuel. But it is not surprising that the view that an export tax on oil-seeds and oil cakes should be imposed in order

to check exports and to bring oil-cakes within the purchasing power of the cultivator has found much favour and even received the support of the Board of Agriculture in 1919, and of the majority of the Indian Taxation Enquiry Committee, but not that of the Indian Fiscal Commission. Some witnesses before us went further and urged the total prohibition of export. Whilst we fully recognise the advantages to Indian agriculture which would follow from a greatly-extended use of certain oil cakes as a manure for the more valuable crops, such as sugar cane, tobacco, cotton and tea, we cannot but feel that those who suggest the attainment of this object by the restriction or prohibition of exports have failed to realise the economic implications of their proposal.....In these circumstances, it is an economic axiom that an export duty will be borne by the producer and that the cultivator will, therefore, receive a lower price for the oil-seeds exported..."—(P. 88). (27-29, 479)

549. Chain of arguments of R. C. favoured export : "...In the third place, even if restriction on exports succeeded in reducing the price of oil-cakes, this would mean that a section of the agricultural community would be penalised for the benefit of another and much smaller section, for the growers of oil-seeds would probably not be those who would make the most use of the oil-cakes."

"A similar line of reasoning applies to oil-cakes..."—(P. 88-89)

It is useless to follow this chain of arguments. If the oil-cakes are used for enriching the Indian soil, the seed-grower, owing to the fall in their price, may get a less return, and, therefore, the enrichment of India's soil by manuring is tabooed. The argument that growers of oil-seeds are one set of persons, and users of oil-cakes are other sets, does not require a moment's scrutiny. There is no such compartment. Really the same man grows oil-seeds and potatoes and tobacco. Even if the opposite were true, the consideration should be the welfare of India as a whole. (27-29, 479)

550. The export of bones to continue: On the same chain of arguments the export of bones must continue. This time there were no cultivators' interests to weep for ; it was the interest of the poor collectors of bones that will suffer. In the words of the Commission,

"Nitrogen deficiency can be remedied to some extent by the application of bones and bone-meal. This form of fertiliser is, however, of greater value as a means of rectifying the deficiency of phosphates which, as we have pointed out, is more prominent in peninsular India, and Lower Burma, than that of nitrogen. As with other forms of combined nitrogen, an important quantity of this fertiliser is lost to India by a failure to apply it to the soil and by export...."—(P. 92). (27-29, 479)

551. Bone-meal trade of India: And yet, in the opinion of the R. C., this export must continue. In whose interest? England must have bone-meal and organic fertiliser ; also other white peoples must have

them in order to enrich their lands. India is recommended to import artificial fertilisers and export her more valuable natural bone-meal fertiliser. The bone-meal trade of India is wholly in the hands of a close ring of foreign exporters. Stoppage of exports means an end to this line of their business. The Combine of the bone-meal exporters is so powerful that any new-comer in the field of collection of bones for milling has to come to grief. But it is not they for whom the R. C. was advocating this draining away of the fertility of the Indian soil. There are no growers to plead for in this case as in the case of oil. But still how wonderfully the R. C. found out a way!

“...Further, any restrictions on export (of bone) would deprive one of the poorest sections of the population of a source of income of which it stands badly in need.”—(P. 92)

But cannot this poorest section be employed in the same work, and the bone-meal returned to the Indian soil? Is it an impossible task for the Government, bent upon improving the productivity of the Indian soil? Arguments are useless before these dispensers of India's destiny, because they know what is what! It is not that they are wanting in knowledge of facts, but it is the clash of interests that stands in the way. This Royal Commission was presided over by Lord Linlithgow and he continued to preside over the destiny of India this second day of October, 1943. He will go and go in a few days, but the system of exploiting the poorest under the pretext of serving them does not go with him. (27-29, 479)

552. Mixed farming for prosperity : This Chapter on mixed farming and cottage industries is closed with the belief that enough has been put before the reader to convince him about the necessity of mixed farming or agriculture combined with animal husbandry and dairying, and also of the necessity of the provision of work for the well-built, well-fed bullocks of the future by way of carting, pressing, crushing and other cottage industries. (658) The benefits and prosperity that will accrue out of the greater production of milk will make the people healthier and happier. (27)

CHAPTER XV

STATE ORGANISATION TO SAVE THE COW

553. The Imperial Dairy Expert : When Dr. Wright was in India in 1936-37 for five months to report on the development of the Cattle and Dairy Industries of India, the Government organisation for Dairy Industry Development was practically *nil*. All dairy improvement work was at the time centered in one person, the Imperial dairy expert. At the Imperial Dairy Institute at Bangalore was located his office. His permanent staff consisted of two officers of class II. and four officers of class III. A farm of 198 acres was attached to the Institute. It was used chiefly as a teaching centre.

In this environment, and with the above assistance, the Imperial Dairy Expert had to attend to the following duties :

(a) The giving of advice to the Agricultural and the Veterinary Departments in the provinces and Indian States ;

(b) The training of post-graduate students, and of students desiring to qualify themselves for the Indian Dairy Diploma ;

(c) The testing of dairy products for the public where such tests are of a special nature, not normally

falling within the duties of public analysts and other officials ;

(d) The prosecution of research work into problems connected with the dairy industry, including the investigation of the methods of handling and transporting milk and the utilisation of milk and milk products ;

(e) The testing of new types of dairy machinery and equipment.

Practically little work to serve the whole of India could be done, although the list of duties, from (a) to (e) seem to be a very imposing one.

“It is obvious from this brief statement that the facilities and staff available at the Centre and in the provinces is utterly inadequate to meet the needs of a branch of agriculture of the magnitude of Indian Dairy Industry.” (*Wright's Report*)

Some improvements have been worked out after that. But owing the war closely following the initiation of these changes, not much advancement can be expected to have been made during these intervening years.

But dairying is only one aspect of the question of the improvement of cattle or of the care of cattle in India. Animal husbandry work includes a much larger field. It includes production and the rearing of animals, their nutrition, and prevention of diseases. It includes the marketing of the animals and animal products, of which dairying forms a part.

554. Animal husbandry defined : India has no such Animal Husbandry Department. There may be

some confusion about the meaning of the term Animal Husbandry. Animal Husbandry is not a science by itself, but is the science of utilising various scientific researches belonging to the sphere of animal breeding and rearing, and also of dealing with the connected animal products.

One branch of Animal Husbandry, namely, dairying, has been allotted by the Government of India to the Imperial Dairy Expert ; similarly another branch, that of the treatment of diseases, is under the charge of the Veterinary Department. Other functions are scattered over in the Agricultural and other Departments.

555. Animal husbandry, co-ordinating science : We shall try to have a clear and broad conception of the sphere of animal husbandry. Mr. Buchanan Smith of the Animal Husbandry section of the University of Edinburgh had put in an explanatory definition of Animal Husbandry :—

“The aim of the science of animal husbandry is the efficient production of farm live-stock ; it deals with the application of those basic sciences which affect the production and maturation of our farm live-stock. The principal sciences from which it derives are genetics, nutrition, animal health, economics and physiology, both reproductive and nutritional”

“The science of animal husbandry does more than apply the sciences from which it derives ; it co-ordinates them. The real function of the scientific animal husband-man consists not in the direct application of new knowledge or the testing upon a

large scale, of such hypotheses as its basal sciences may bring forth, but in the relation of new facts to existing circumstances. This implies that animal husbandry is not merely an applied science: it can evolve new techniques and can prosecute research"

"... .. For example, there is the science of animal husbandry, based on the science of nutrition; the science of nutrition alone can make little contribution to the welfare of mankind through live-stock without taking into consideration other basal sciences. Thus there are developed animal husband-men, who are primarily nutritionists but who also must have sufficient understanding of the principles and findings of the other sciences to enable them to co-ordinate the work with which they are mainly identified. In the same way, there are animal husband-men who are primarily either veterinarians or geneticists."

556. Animal husbandry applies science to stock-production: "A precise definition cannot be confined to a few words. Briefly, animal husbandry may be defined as that branch of science which interpretes, co-ordinates, and finally applies the result of science to the problems of live-stock production."

In India this synthesis, this co-ordination of the genetecist and the nutritionist, the veterinarian and the agriculturist has been markedly wanting. And it is, therefore, that animal welfare work in all its aspects, from breeding to rearing and utilisation, and the

combating of diseases, as a unified whole, is very lamentably wanting.

Sir Arthur Olver, who was a scientific animal husbandry-man, endeavoured to bring the Central Government to co-ordinate the various component parts into one whole. His recommendations have not been given effect to. There must be constitutional or practical difficulties. But they should not be insurmountable.

557. Animal husbandry work : now done piecemeal : 'The Government animal husbandry expenses are included in the Agricultural Departmental budget. There it is sub-divided. Some work remains directly under Agriculture and some are transferred to the Veterinary Department, which again is a part and parcel of the Agricultural Department. This has failed to put life into animal husbandry work, for no body is directly responsible for the whole. There are and have been animal husbandry experts attached to the provinces and to the Centre. But their more or less advisory function has not contributed to the growth of animal husbandry, commensurate with the expenses, however inadequate these expenses may be. That full advantage was not being taken of the very inadequate budgetary sanctions had been the cry of Sir Arthur Olver. It was so because of the defective administration in its very conception.

558. Olver's suggestion on re-organisation : In his note presented to the Animal Husbandry Wing, 2nd Meeting, Sir Arthur Olver says :

“... . it is clear that the allotment of funds ... for Animal Husbandry as a whole is still very inadequate and disproportionately small compared with what is spent on Plant Husbandry. Moreover, there is still, in most provinces, nothing which can be described as a comprehensive Animal Husbandry organisation, such as exists in other countries, with staff and facilities for dealing all aspects of Animal Husbandry, under the unified control of a specialist in such work. Only in the Punjab and the North-West Frontier Province is Animal Husbandry work of all kinds dealt with by one department, viz., the Provincial Veterinary Department, under the unified control of a specialist. And it is significant that in these provinces, progress in organised live-stock improvement has greatly exceeded that of provinces in which similar unified control does not exist and in which at present some Animal Husbandry matters are dealt with by the Director of Agriculture, some by Director of Veterinary Services, and some not at all.” (581)

559. Creation of a Director of animal husbandry :

“That the live-stock officers who were employed under the control of Director of Agriculture in most provinces of British India have done good work with the funds and facilities at their disposal, I freely admit, but without an Animal Husbandry organisation at their backs, covering the whole province, or at least the principal areas, where live-stock are bred and devoted solely to live-stock

interests, it is difficult to understand how they could have been expected to produce the general improvement of the stock of the country which is needed. It seems to me, therefore, that the right policy would be to amalgamate all the live-stock personnel at present employed under Provincial Directors of Agriculture with the existing Provincial Veterinary Departments, and to place Animal Husbandry work of all kinds, e.g., disease control, breeding control, systematic castration and inoculation of improved animals, and official registration of pedigree stock as well as the marketing of Animal Products under the general control of a Director of Animal Husbandry, on the lines which have been so successfully followed in eminently successful agricultural countries such as Denmark, the U. S. A., New Zealand, Australia, the Union of S. Africa and all the more important British Colonies"

"I visualize, for example, that specialists would be needed in Dairying, sheep and goats and poultry, and for the marketing of Animal Products, and it would be necessary that the Director of Animal Husbandry should have, at his sole disposal, funds and facilities, more in conformity with the greater economic importance of live-stock and live-stock products in comparison with crops, than is at present the case..."

The following figures illustrate Sir. Arthur Olver's criticism :

560. Comparative statement showing expenditure on Plant and Animal Husbandry work in Provinces during 1935-'36.

TABLE—36

Province.	Animal Husbandry	Plant Husbandry	Total Agri.	Percentage	Allotment for live- stock work from budgets of Agriculture Departments. Percent- tage. (6)
	(Total budget of Dept. Allotment for live-stock from Agri. Dept. budget minus expenditure on Vet. College). (1)	(Total budget of Agri. Dept. minus allotment for live-stock, minus expenditure on college). (2)	excluding expenditure on Agriculture & Veterinary colleges. (1+2) (3)	of total spent on Vet. and live-stock. (col 1/ col 3) (4)	
	Rs.	Rs.	Rs.	Rs.	
Madras	... 9,67,100	15,82,700	25,49,800	37.93	1,15,800 6.27
Bombay	... 4,63,000	10,00,000	14,03,000	28.86	91,000 7.40
Bengal	... 3,82,067	9,40,633	13,22,700	28.88	54,367 5.48
Punjab*	... 11,71,036	23,60,264	35,31,300	33.16	* ...
U. P.	... 5,56,733	19,11,562	24,68,295	22.47	1,20,738 5.23
C. P.	... 4,81,020	7,03,346	11,84,366	40.61	95,020 10.55
Bihar & Orissa*	... 4,82,993	6,49,399	11,32,392	42.74	* ...
Assam	... 2,56,589	3,71,495	6,28,084	40.84	1,15,386 23.68
N. W. F. P.	... 1,28,700	2,15,000	3,43,700	37.44	... ..
Average excluding Punjab, Bihar-Orissa and N. W. F. P.— 7.57					

* Expenditure on live-stock work is met wholly from Veterinary Budget or partly from Veterinary and partly from Agriculture budgets. Hence figures are not given.

"...From these it may be seen that the total expenditure on Animal Husbandry work of all kinds, including disease control and the treatment of the sick, and veterinary education, is less than half the amount spent on plant husbandry, though it is generally admitted that in India Live-stock are of special importance because they are used for cultivation of the land, and milk is of special value because the diet of the people is predominantly vegetarian."

But things move slowly, and after so many years when Sir Arthur Olver having retired has ceased to advise, the old ways still continue and animal husbandry occupies its old place in the administrative scheme, although it is the one department which by its growth could have contributed materially to the improvement of the economic condition of the people. In India we have breeds of cattle about which we now know that they are second to none anywhere in the world, taking milking capacity or draught capacity, as you like.

With such wealth at our door, complaint is made of there being too many weedy animals; their slaughter is advocated, and practically very little is done to convert the animals into sources of wealth by scientific animal husbandry practice.

The above Table has been given, as drawn up by Olver in 1933. Later, in 1936, Dr. Wright brought out the figures in which the total percentage of animal husbandry work is shown which includes veterinary work plus expenditure on live-stock improvement, as also on improvement work alone.

561. Expenditure on live-stock improvement and veterinary services.

TABLE - 37

Province.	Agricultural Department.		Proportion allotted for live-stock improvement.	Veterinary Department		Total for Veterinary & Live-stock improvement.	Total budget for both departments.		Proportion utilized for Animal Husbandry
	Total budget.	Rs.		Rs.	Total budget.		Rs.	Rs.	
Madras	18,47,000	1,15,800	6.2%	9,63,000	10,78,800	28,10,000	38.3%		
Bombay	12,29,000	91,000	7.4%	3,78,000	4,69,000	16,07,000	29.2%		
Bengal	9,95,000	54,367	5.4%	4,82,000	5,36,367	14,77,000	36.3%		
Punjab	25,96,500	53,836	2.1%	12,91,000 +	13,44,836	38,87,500	34.6%		
U. P.	23,62,300	1,20,733	5.1%	4,36,000	5,56,738	27,98,300	19.9%		
C. P.	9,00,000	95,020	10.5%	3,86,000	4,81,020	12,86,000	37.3%		
Bihar	6,92,617	43,218	6.2%	5,21,574 +	5,64,792	12,14,191	46.4%		
Assam	4,86,881	1,15,386	23.7%	1,41,203	2,56,589	6,28,084	40.8%		
N. W. F. P.	2,15,000	...	...	1,28,700 +	1,28,700	3,43,700	37.2%
Total	1,13,24,298	6,89,365	6.1%	47,27,477	54,16,842	1,60,51,775	33.7%		

* Expenditure on veterinary departments plus expenditure on live-stock improvement allotted by the agricultural departments.

† The amounts allotted for live stock improvement by these veterinary departments are as follows : Punjab Rs. 2,82,900, Bihar Rs. 58,151, N. W. F. P. Rs. 20,200.

—(Wright's Table—42)

The Table shows that the total veterinary expenditure is less than at the time of Sir Arthur Olver's note, and that the expenditure on the improvement of live-stock has gone down from 7·57 to 6·1 per cent. In other words, there has been retrogression in Animal Husbandry and not development.

When we come to examine the staff employed by the Government for looking after the animals, the figures reveal nothing but neglect. (*Wright's Table-41*).

562. Table of agricultural and veterinary officers in British provinces in 1936-'37 :

TABLE-38

Provinces.	Agriculture.		Veterinary.	
	Gazetted.	Non-gazetted.	Gazetted.	Non-gazetted.
C. P.	25	166	7	163
Bombay	38	208	9	143
Madras	59	464	23	274
Punjab	69	236	36	406
U. P.	44	274	4	226
Bengal	26	188	13	174
Bihar	18	113	11	139
Orissa	14	14	2	28
Assam	9	54	2	60
N.W.F.P.	5	18	2	33
Total	307	1,735	109	1,646

The total number of gazetted veterinary officers is 109 and of non-gazetted officers is 1,646. This number includes the teaching staff for colleges or schools. Leaving out the gazetted officers, the 1,646 non-gazetted officers work out on the 215 millions of cattle at one officer for every 1,30,000 cattle.

Here is another Table in which is worked out the number of animals per veterinarian, Province by Province.

563. Cattle per veterinarian and per capita expenditure :

TABLE—39

Number of cattle per veterinary assistant and expenditure per head of cattle in British provinces :

Provinces.	Number of cattle per veterinary assistant	Expenditure on veterinary services and live-stock improvement per head of cattle. (Pies)
N.W.F.P.	29,500	23·8
Punjab	36,000	16·3
Bombay	65,500	9·1
C. P.	81,500	6·7
Madras	82,500	8·4
Assam	96,500	8·2
Bengal .	1,35,000	4·1
U. P.	1,41,000	3·3
Bihar	1,42,000	5·1

—(*Wright's Table—43.*)

The fate of the cattle can be understood in the matter of intelligent care and medicinal service accorded to them. The highest expenditure, excepting in the N. W. F. P., a very small Province, is in the Punjab, 16·3 pies per head of cattle. The work in the Punjab is best done and the expenditure has, therefore, doubly profited the animals there.

564. Animal husbandry in India and U.S.A. : In this connection figures for the United States of America should offer interesting comparison.

**ANIMAL HUSBANDRY DATA BASED ON
1929-30 FIGURES (Olver).**

1. Number of live-stock.

U. S. A.	181 millions, including pigs.
B. India.	220 „ including pigs and poultry.
All-India.	300 „ approximation.

2. Gross value of animal products.

India—in Sept., 1929	—1,900 crores of rupees per annum.
India—re-valuated by Wright	—1,000 crores of rupees per annum.
U. S. A. in Sept., 1929	—6,243 million dollars ; =1,711 crores of rupees per annum.
U. S. A. crops	—5,680 million dollars ; =1,556 crores of rupees per annum.

**3. Provision for Animal Husbandry Services
from Central funds (1929-30)**

U. S. A. Bureau of Animal Industry—	446 lakhs.
British India from Central funds	
for Pusa and Mukteswar—	14 lakhs.

Details of Central Budget (1929-'30)

(a) Agricultural Sections	9.1 lakhs
(b) Animal Husbandry Section Karnal, Bangalore, Wellington and Anand Institutes. Imperial Dairy expert and physiological chemist	6.8 lakhs.
(c) Mukteswar	7.9 lakhs.

Total 23.8 lakhs.

Less Income from Mukteswar 8.1 lakhs.

Net expenditure 15.7 lakhs.

The Mukteswar Institute by supplying serums and vaccines was making profit (8.1 lakhs) against its expense of 7.9 lakhs. The principle of making profit at the expense of the provinces was deprecated by the Royal Commission of Agriculture. But it appears that the Central Government even after the recommendation of the R. C. did not want to lose its profit.

565. Insufficient field-work : Little field-work in the matter of prevention of disease or of the improvement of cattle can be expected from the paucity of men in service. The District Board maintains dispensaries and hospitals for animals. The men employed would have no other work to do if they had properly to attend to this particular work.

There is an itinerary-staff for the control of epidemics. But looking at the work they have to do, they are likely to be of use only when the epidemics almost spend themselves out. For the method of receiving information is as faulty as the staff is under-manned.

Improvement and castration activity is just beginning to be felt. But what is done is a mere drop in the ocean.

566. Bull policy for non-descript areas : The supply of *bulls* to *non-descript areas* is going on against the principles enunciated by experts. The opinions of Bruen and Olver have been quoted in connection with the improvement of breed in non-descript areas. The latter had warned us of the danger of certain present practices in the supply of bulls :

"...There is, in fact, a definite danger that the ultimate effect of distributing bulls in such small numbers may be the production of stock which, under existing conditions, will eventually become degenerate like the local stock, and of even more mixed origin. Such work requires moreover to be very carefully controlled by experts, backed by animal husbandry organisations capable of rendering systematic assistance to breeders, throughout the country, and of undertaking the systematic study and control of the host of adverse factors which now make the rearing of good stock a practical impossibility in many parts of India."

—(*1st meeting A. H. Wing, 1933.—P. 261*)

In spite of this clear warning bulls are being distributed in non-descript areas, for example in Bengal, without any regard to the degeneration that might come in the next three or four generations. The work of experimenting with superior bulls should have been conducted under supervision in Government farms first, and when the results were proved to be satisfactory, the work of distribution of outside bulls could have begun. No harm could have happened by this delay. For the span of 10 or 12 years could be well spent in improving the fodder-growing conditions, in effecting selection and breeding from better specimens of the acclimatised stock, and for organisational work for the prevention of preventible diseases. All these and more could have been done. There is no justification for hurriedly distributing bulls on *pro rata* scale, such as one hundred per district etc., with only a few

officers in the staff to look after the welfare of the millions of poor, unthrifty cattle.

567. Super-annuated distribution of bulls : There seems to be little justification for this sort of super-annuated distribution of bulls all over the provinces when the problem can be tackled by concentrated work in a better way.

Harianas are being brought to Bengal. There is a dearth of Haryana bulls of pure descent in its own soil in the Punjab and the U. P. Instead of sending the 2,500 bulls to Bengal on an uncertain mission, these could well have been used in the Punjab, the N. W. F. P. and the U. P. for positively better breeding.

The total want of better bulls is one million, and the replacement demand is of two hundred thousand bulls per year. It is no use scattering a handful of bulls in Bengal, Bihar, Assam or Orissa amongst the millions of non-descript cattle in bad environments.

The want of men in service is due partly to the insufficiency of arrangements for training and also due largely to the aversion of the service-seeking class for animal husbandry work.

The change in the cultural side has been deplored. The extinction of village communities has hastened ruin. And the cultural change has become so great that those who take up veterinary service or for the matter of that agricultural service, are not held in the same respect as, for example, a doctor is held.

The arrangement for veterinary and allied education to turn out capable animal husbandry men is

altogether inadequate. There are only a few schools and colleges all over India, and the number of trained men turned out annually is absurdly small. While institutional training is wanting, the tradition that created good breeders and veterinarians in the villages is also fast disappearing.

After the Report of Dr. Wright some arrangements at the Centre for higher veterinary and dairy education and training have been in the contemplation of the authorities, but owing to the war no tangible progress is observable.

568. Veterinary education : Education is a sore point whether veterinary, agricultural or general. There is no sense of reality attached to these. The courses are joined and passed through as a matter of routine. There has been a divorce of education from its real objective. Nowhere is it felt more than in the village life of the agriculturists. Their children go to school and learn how not to imbibe the sound, practical instinct of the agriculturists or the villagers. Primary education, even in the villages, has no reference to village life. (15)

569. District Board and veterinary help : The amount spent on education in the Provincial and District Board budgets are not inconsiderable. The District Boards derive their income from the poorest class, and it has a wide-spread organisation. In the District Board budgets, education is a considerable item. But the manner of spending it on education and on the educational institutions is the reverse of satisfactory.

The Punjab cultivators objected to paying for the District Board bulls supplied for the improvement of the village stock. They argued quite naturally that as the District Board funds were contributed by them, there was no reason, therefore, why the bulls bought out of their contributions should be paid for again. They refused to pay twice, once indirectly as cess to the District Board and again as direct cash or instalment value of the bulls purchased from the indirect contribution. A sound argument, which probably the District Board had to accept. Similarly, in the matter of education they could have asked the District Boards to educate and train their children for plant and animal husbandry work in all their elementary aspects. That would have been a right claim. That claim is neither put forward nor thought of. (15)

570. **The trend of education :** When any student goes to an agricultural or veterinary school or college, he goes with a disposition which makes him a misfit. He goes on through the course and ends in getting a post which is his only inducement for joining the school or college. No one goes to join an agricultural institution or veterinary institution for becoming an animal husbandry-man on his own account. There are rich cultivators who could afford to have their children educated and trained for their profession. That would have created an atmosphere of reality. That is wanting. It is, therefore, that in spite of the little advances in agricultural and veterinary education, these have not touched the life of the cultivators.

From beginning to end the educational structure is unreal and a super-imposed one. The results become painfully apparent in schemes of veterinary higher education that are formulated and worked out. (15,597)

571. Educational need of the moment : The need of the moment in the country is for spreading elementary knowledge on animal husbandry subjects. These should be incorporated in the curriculum of every elementary school combined with facilities for practical work. The arranging of practical work on elementary animal husbandry is easily possible and will meet a vital necessity in changing the dead character of villages by infusing fresh life into them. A lead from the State is needed for this. The State within the State or the *village communities* could do it and carry out the necessary reformation in village life when the State failed to do its primary duty. (15, 597)

572. Veterinary colleges : So much about elementary education on animal husbandry for the masses, which is wholly wanting. For higher education there are five colleges in India, at Calcutta, Bombay, Madras, Lyallpur and Pusa. These colleges turn out Veterinary Assistants. (15, 597)

573. Proposed central college : For the higher services there is need for a Central College. There is a proposal before the Government for establishing a college at Mukteswar, Izatnagar, which will train up to what would be the M. R. C. V. S. course of England. The scheme provides for the training of 10 or 12 students through a five-years course, the first

two years of which may be completed in a Provincial college, should such a college get enlisted by adopting these first two years' curriculum. The provision will be for 70 students at the laboratories etc. The estimated initial expenditure was about nine lakhs of rupees (pre-war) and the recurring expense was of two lakh ten thousand rupees. (15, 597)

574. Rs. 20,000 for training one man: Distributed amongst 10 students who are likely to come out successful at the end of the five years' course, the *per capita* expenditure on every student works out at twenty thousand rupees. M. R. C. V. S. diplomas could be obtained at a very much cheaper cost to the State by sending out students on State scholarships to England. It is better certainly to have a high grade Central College in India. But can India afford to spend Rs. 20,000/- on one student for training him for veterinary service?

The need of the hour was the dissemination of the elementary knowledge on nutrition and dairying—elementary knowledge but scientific and refreshed with the latest research results that the researchists have been annually adding. (15, 597)

575. Inadequate preventive service: Disease-combating is the chief item of importance in veterinary work. The Central Research Institutes are conducting this work, but the results of their researches are not reaching the villagers as speedily as it should, because of the lack of a sufficient number of Veterinary Assistants. There has been an endeavour for training up stocks-men, who will be able to attend to the

ordinary ailments and to vaccinate and inoculate. Thousands of such stocks-men could at once find employment should the Government set up a suitable organisation, recruit them, train them and send them out to the villages. They could with the assistance of preventive measures stamp out the scourges of epidemic that take a tremendous toll every year.

The State Animal Husbandry Department, if it were responsive to the crying needs of the country, should proceed along the following lines, which have been already discussed in connection with the problem of saving the cow.

Here is a recapitulation of some of the points :

Arrangement for introducing education on animal husbandry in the course of general primary education, combined with practical work as envisaged in the Wardha scheme of Basic Education. Let the boys grow cattle-minded and learn to handle cattle, love cattle and serve cattle from the beginning of their life.

District Boards should utilise education grants in conformity with the above and also should increase animal husbandry and veterinary grants. (597)

576. Change needed for the protection of the cow : The cow has to be lifted from the unfair competition of the she-buffalo. At present the Government policy is to look upon the she-buffalo as the milch or dairy animal. The Royal Commission put its stamp on it, and officially the she-buffalo still remains the dairy animal and not the cow. The Government should by this time be able to realize the disastrous results of depriving the cow of her natural position

as the giver of milk, and as the one animal providing draught cattle and milk. The old policy should change, giving place to a new, and each and every item of unfair competition should be removed :

(a) By disseminating education of the nutritive value of cow-milk and of cow-*ghee* as compared with buffalo-*ghee*.

(b) By preventing the passing off of buffalo-milk as cow-milk by mixing water with it, and by legislating against the marketing of a toned-down adulterated milk and passing it off as cow-milk. All idea of standard milk, which is now ruling the Government health and milk analysis departments, should go. Milk should be the pure product from the udder, and should be classified as pure cow-milk and pure buffalo-milk.

(c) Preference should be given to milk and milk products from the cow as distinct from buffalo-products. Cow-*ghee* should have a legally higher value on account of its better character in the matter of its carotene-content. *Ghee* should be protected from adulteration with vegetable products. Mixed *ghee* should legally disappear from the market (cow and buffalo) as detection of adulteration becomes difficult on account of the longer range to be given to the determining limits of tests.

(d) By disseminating the knowledge of the nutritional value of skimmed milk and encouraging the use of whole milk in preference to *ghee*. (597)

577. Creation of fuel fodder reserves: The Government is to arrange the supply of fuel to the

cultivators at nominal cost. In order to save cow-dung from being burnt, coal or wood should be supplied very much on the lines indicated by Dr. Voelcker. The Government may allow rent remission directly and in permanently-settled areas through the *Zemindars* for land put under fodder crops. It should utilise canal banks and railway embankments for the cultivation of tree-fodders. It should create and conserve the fertility of the soil by prohibiting the export of oil-seeds, oil-cakes, bones and fish manures and arrange for their application either as cattle-food or as manure for the soil. In the absence of an export market for oil or its export facilities, land used for growing surplus and exportable oil-seeds should be used for other suitable crops. (28, 31, 411, 444-'53, 462, 597)

578. Effective prevention of epidemics : Prevention of disease and service to cattle should be managed through the training of hundreds of stocksmen in the elements of animal husbandry, nutrition, dairying, castration and in the processes of vaccination and inoculation, and supplying them on occasions of enzootic outbreaks with free vaccines and serum according to plan and under the direction of the Animal Husbandry Department to which they might belong. (597)

579. Utilisation of cattle power : The Government is to foster the utilisation of cattle power in place of coal-or-oil-generated power for traction or the driving of the shaft. This will involve the protection of cottage industries against the competition of mills. (24, 26, 412, 528, 544, 597)

580. Effective measures for breeding and castration : The Government is to facilitate the grading up of breeds where they exist to pure breeds, and to put more milk into all cows, whether of the draught type or of the milch type. For non-descript areas, it should reserve the experiments of mixing better blood to its own farms and institutions. And in the meantime, till definite results are obtained, help the villager in selecting and improving the existing cattle by better feeding and other known and practised methods and by the elimination of scrub males and females through educative propaganda and helpful measures. (597)

581. Re-organisation : The Government is to reorganise the work of the Animal Husbandry Department. The work now is partly done from the Agricultural and partly from the Veterinary Departments. A separate Department of Animal Husbandry should be created in which the existing Veterinary Department is to be included, also such of the staff from the Agricultural Department as are employed in Animal Husbandry work. The Veterinary Department as it exists should form a part of the Animal Husbandry Department to be created.

The number of Assistants now called Veterinary Assistant Surgeons should be very materially increased, and the existing staff should be given refresher courses of training in animal nutrition, genetics and dairying.

The existing colleges should extend their curriculum so as to include animal nutrition, genetics and dairying in it.

Provision should be made for training and employing hundreds of stocksmen to carry out the policy of the Director of Animal Husbandry in the field.

In the field of Animal Husbandry the essential requirements at the present time are :

- (1) Animal nutrition ;
- (2) Breeding and castration for the improvement of the existing stock ;
- (3) Putting more milk into the cows and prevention of competition of the buffalo with the cow ,
- (4) Prevention of disease by inoculation and vaccination ;
- (5) The cow should be the one animal of first care from the Animal Husbandry Department and the emphasis put on horse and horse surgery should give place to the nutrition of the cow ;
- (6) The present Veterinary Assistant Surgeons should be re-named, Animal Husbandry Assistants. The Animal Husbandry Assistants and the stocksmen should connect the villager with the Departmental head and through him with the Mukteswar researches. (558, 597)

582. Pinjrapoles : *Pinjrapoles* and *Pinjrapole Goshalas* are institutions for the protection of the cow in particular, and of all domestic animals in general. (597)

583. The place of Go-rakshani Samiti in saving the cow : The *Go-rakshani* Samitis first came into existence when Indian culture was mainly based on village communities. The breeders and the farmers

maintained cattle for reproduction and for work or milk. The owners maintained them well when they were a direct source of income. But when they became unremunerative due to old age or accidents, there were neither the arrangements nor the skill to look after them, and the cow suffered and slaughter became the only way out of the difficulty. But sentiment forbade this and the animals had to be taken care of. At this stage the *Go-rakshani* Samitis came into existence. A group of villages joined together co-operatively to look after such animals. Funds were provided by the philanthropic people from their charity funds. The farmer and the breeder consented to pay a small levy or lot on their produce. The management was vested in the hands of Mahajans.

But, now, with the coming in of British Raj these things have changed. These institutions are no longer community bodies, neither do they care to look after the welfare of the animals or of the owners from whom they came. The miserable picture of the *Go-rakshani* Samiti could be seen everywhere.

These institutions can be of good use to the public in saving the cow. Some suggestions as to how they can be made useful are given by a resolution of the *Go-seva Sangh* passed on 1-2-1942, which runs thus :

The real aim of the *Pinjrapole* and the *Goshala* is to give protection to the sick, old and inferior animals and save them from the life of pain and agony. In the opinion of the *Sammelan* it is

necessary to improve the lines of working or management of the *Pinjrapoles* in the following manner :

(1) In every institution arrangements should be made for rearing, treating the ailments and other such things, and its advantages should be made available to the cow-keepers in the neighbourhood ;

(2) All the inferior and low grade animals should be stopped from reproduction and the better grade cows should be made to give more milk and produce better bullocks by better feeding, breeding and management ;

(3) Every institution should maintain high grade bulls and make their use available in the vicinity ;

(4) Every institution should have enough grazing lands where the dry and young stocks of other breeders could be maintained at reasonable cost. High grade bulls should also be kept there ;

(5) Green fodder or silage should be produced and preserved in sufficient quantities ;

(6) All the buildings in the *Pinjrapole* should be constructed with due regard to sanitation and hygiene, and other arrangements like wells, irrigation, fencing should be planned on definite and scientific lines ;

(7) Every institution should employ a cattle expert, and everything should be run under his control. He must be well-versed in cattle management, fodder farming and veterinary science.

The Government and all others concerned should co-operate with the *Pinjrapoles* in their attempts to save the cow, and enlist their co-operation in all measures for protection and improvement. The *Pinjrapoles* may occupy a very large place in saving the cow in the future, apart from the immediate noble and humanitarian office they have been fulfilling.

The Cow In India

VOL. I

PART—III

NUTRITION OF THE COW

PART—III

NUTRITION OF THE COW

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CHAPTER XVI

THE IMPORTANCE OF NUTRITION

584. Cow—the domesticated animal: Wild animals in a state of nature choose their food instinctively—such food as may maintain them in health. Under domesticated conditions, the animal has little choice about food. A cow may eat what is made available to her by her owner. Insufficiency in quality and in quantity may trouble her. She has to submit to whatever condition of living her owner may have imposed on her. To the extent that man fulfils the part of an able guardian the animal thrives. When the conditions become unfavourable, the animal is a burden to the owner and in the end succumbs either to mal-nutrition or to disease. The science of nutrition provides us with the clues by following which, domestic animals may be kept healthy. The more man deviates an animal from its natural life, the more trouble he has got to take to look after it.

585. The task imposed on the cow: The milch cow and the working bullock are men's artificial creation. A cow is expected like all other animals to supply milk enough for her off-spring for such a period as it cannot take any other food. At the rate at which the power to assimilate normal food develops in the off-spring, the need for milk diminishes and the supply at the teat also diminishes.

The milch-cow is required by man to perform quite a different task. She is required to give more milk and yet more milk. Under the circumstances, merely providing plenty of pastures cannot carry her very far.

586. Roughage and concentrate feeds : Men are not satisfied with 10 lbs. of milk a day in those types in which the udder has been built to a higher capacity by training for many generations. What applies to the cow applies to the bullock also. The more work is required of it the more feed becomes necessary. Feeding for meeting both these classes of necessity—milking and work imposed by man upon the cow—cannot always be got out of pastures, however plentiful. The reason is that they have a limited capacity in their pouch. As much as the belly can hold they may consume, and no more. But when more production is needed either in the form of milk or in the form of work, more feeding-material has to be put in; otherwise the animal will fail to perform the task demanded of her. To meet this exigency, concentrated food is given to the cattle, a small bulk of which can substitute the place of a large quantity of herbage. Such concentrated foods are the cereals and pulses and oil-cakes. In cattle-farms these foods are called “concentrates” as distinct from the herbages which are called “roughages.” Roughage does not mean useless stuff, it means that it is a bulky food, designed to fill the belly of the animal and get some nutrition also.

With the introduction of concentrates in the feed of the cow, men have found a means of enormously increasing the feeding capacity and, therefore, the

productive capacity of the animals—the cow for milk, and the bullock for work. With their introduction, the responsibility of man for the intelligent feeding of the animals has further increased.

587. Stall-feeding : A combination of the herbage and the concentrates is made for stall-feeding. A cow has to travel long distances and spend energy for feeding on pastures. Bullocks are required to work at day time ; and they are allowed little opportunity to feed on pastures. If they are to spend the day in search after food, they will be able to give little time to productive work. Man, therefore, has developed the system of stall-feeding. The animal will not have to go roaming about for gathering food from pastures, but will find all that it may need at the barn near him—fodder, concentrates and water, and everything else. The cow has taken gracefully to all these interferences of man ; and instead of fretting at the treatment, she has put forth all her natural functions to accommodate herself to the desires of man. In this arrangement there is little to cavil at. The cow gets her need, and men satisfy their needs out of caring for her by providing her a home and a shelter and also by supplying all her other needs. Both have progressed. Because of this mutual dependence the cow has become a better animal and man a better man than what they were before they came together, i. e., before the cow was domesticated. (981)

588. Knowledge of nutrition for proper management : The principal duty of an owner of the cow is to see that she is properly fed and exercised,

watered, cleaned and housed, in short, properly managed. Within management is included every aspect of cattle-rearing. Of the items of good management, care of feeding or nutrition takes the first place.

In order to discharge this function of feeding the cow, the elements of nutrition have got to be thoroughly grasped. It may be said that men have been keeping their cattle for thousands of years without any particular scientific knowledge of their nutritional needs. Some fodder, some concentrates in the shape of oil-cakes or cereals or pulses, they were being given all the time and they have been thriving. Therefore, there can be no plea for entering scientifically into the subject of feeding—a subject which, in the opinion of many, does not require theoretical knowledge but only practical experience. This, however, is not the correct attitude to take up. Men have been living and eating and maintaining themselves from the beginning of their creation. But the necessity of knowing more about food and health requirements had never been pushed to the background. Our knowledge is increasing and we are profiting by the increased knowledge of nutrition, and health and hygiene. The same applies to the domesticated animals. The more scientifically we know about their requirements, the more can we manage them successfully to the profit of both.

The grass and straw we feed them with, may be adequate in quantity; but they are inadequate in quality. This error will be detrimental to the optimum growth and maintenance of the cattle. There is undoubtedly a streak of indifference in men about

matters of their own nutrition and health as compared to the matter of disease. This should go. Even those who ought to know do not much care about knowledge of human nutrition, far less about animal nutrition.

589. Cow-keeping does not pay : In India the cattle have been brought to a condition in which they are ceasing to be economically profitable. That is what is meant by saying that the *ryots are losing interest* in the cow ; it means that cow-keeping causes loss to them. If cow-keeping is not profitable, then what about the future of the nation depending on that very cow at every stage ?

Diseases and their cure are things which men understand easily. In order to find a short-cut to health from disease there is a great deal of dependence upon the physician. The same is true about domesticated animals too. If anything is wrong the veterinarian knows the art of healing and he is sought for where available. It is good and natural. But much better it is to have a knowledge of nutrition and prevent diseases by enough proper feeding and healthy conditions of living. (211)

590. Elementary knowledge of nutrition for all : It is very necessary that every keeper of the cow should have the knowledge of the elementary requirements of nutrition. Want of nutrition may be due to under-feeding or it may be due to feeding to the satiation of the animal with feeds which may be lacking in the essentials of life-sustaining substances.

Where plenty of feeding-stuff is allowed to the cow it is necessary to see whether the essential materials

for sustenance are included in the feed or not. In India, our cattle suffer from want of sufficient materials to eat ; and the inadequate feed they get, even that feed is, in many cases, defective.

591. Deficiency of fodder and mal-nutrition : Want of nutrition and mal-nutrition go side by side, and the results are obvious. In the previous chapters the matter of inadequacy of nutrition in India, as a whole, has been referred to. This inadequacy is now well-known throughout the world. One can find in the technical literature of other lands reference to the inadequacy of cattle-feed in India.

In the Monthly Bulletin of Agricultural Science and Practice, International Institute of Agriculture, Rome, April, 1940, No. 4 entitled, "Present-day Problems of Animal-Nutrition", there is an article on 'Self-sufficiency in fodder supplies', in which the writer brings out the inadequacy of Indian fodder. (*Indian Journal of Veterinary Science & Animal Husbandry*. March, 1941). (21, 386-'91)

592. Indian fodder deficiency—45 per cent : "On the basis of 215 million, heads of bovines (as we have an available supply of 15,54,90,470 tons of dry fodder * from cultivated sources) it is found that only about 4.4 lb. of dry fodder per head per day are obtainable. Even if bran, pollard, etc. are

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- * (a) Straw of crops (moisture 10 per cent) ... 18,51,99,082 tons
 (b) Dry matter content of above 12,16,79,174 "
 (c) Green fodder (moisture 80 per cent) ... 16,90,56,479 "
 (d) Dry matter content of above 3,88,11,296 "
 Cakes plus cotton seed on dry basis ... 88,29,746 "

considered to be fodder, and the amount available is added to the amount of coarse fodder, this will mean only an addition of a little over an ounce per head per day. In this calculation sheep, goats and equines are not taken account of. If one assumes an average body-weight of the Indian animal to be 400 lb., then the food requirement would be about 8 lb. of dry matter per day (inclusive of concentrates). For hard-working animals and milch-cows the amount will have to be increased. The amount of concentrates (cakes and cotton seed) and bran, etc. available, works out to be about 0.2 lb. per head per day. As the fodder-supply should provide about 8 lb. of dry matter per day, and since only 4.4 lb. are available from cultivated sources, there is a shortage of 45 per cent of this substance.

"It is obvious that grass and hay will tend to rectify the deficiency. Whether we can get the additional 45 per cent of the requirement from fodder grasses, cannot be accurately estimated. Much more than this is certainly potentially available and it is for this reason that grass-land improvement measures, and better utilisation of forest areas are of so much importance."

593. Mal-nutrition in rich countries : This shows the extent of fodder shortage in India. The nutritional demand in the first instance is to ensure the 8 lbs. of dry fodder per head of cattle on the average. This is the primary consideration ; but along with this comes the question of the quality of the feeding-stuff. Even in scientifically-advanced

lands, possessing subject countries, where there can be no question of fodder shortage, there is still the question of mal-nutrition, of under-feeding. The deficiency is one of management which, in this case, has to keep itself abreast of scientific investigations and findings.

With all the excellent scientific advice,*with arrangements ready at hand to bring in any nutritive material from any part of the world, with the capacity to pay for such imports, there is, in Great Britain itself, still a lot of mal-nutrition and defective nutrition causing enormous economic losses to the animal husbandry and dairy industries. Mr. W. C. Miller of the Royal Veterinary College, London, in his address brought this fact to the notice of the "National Nutritional Conference," summoned by the British Medical Association, April 1939.

"In all probability the first quarter of this century will be registered in the archives of history as a period when major attention was directed to the elucidation of disease-causation upon a purely bacteriological basis. Subsequently and to some extent concurrently, we have seen a phase of intensive investigation of disease of plants, animals and men, due to viruses; a phase the end of which has not yet been reached. Slowly, during this time, it has been clear that neither the bacterium nor the virus is the complete answer to the question—'what causes disease?' Minerals have enjoyed a phase of popularity, vitamins are fashionable, but though both are important,

neither of them is more than one factor in the cause of disease... ..”

“I think that we may reasonably assume that a further contribution to the solution of the general problem is being made and will continue to be made by the intensive study of the *nutrition* of the organism, viewed as a whole. Considerable progress is being made on the frontiers of this newer knowledge, and although the horizons are as yet by no means quite clear, various avenues are being opened up to give a far more lucid conception of the situation.”

594. Study of health—an end in itself: “The study of health, as an end in itself, and of the measures and methods to achieve and maintain health, must be carried on as a complementary but fundamental study”

“It is necessary to state categorically that if this country is to make the most of its peculiar agricultural advantages, so far as live-stock is concerned, its farmers must take a far more active interest in health than they have hitherto.

“The annual loss of lambs, piglings and calves is enormous, and much of it would be prevented if sound and adequate methods of feeding and rearing were widely practised. Improvements to pastures, adequate supply of vitamins and minerals during winter, and the avoidance of unsuitable food-stuffs during juvenile stages of life, would do much to prevent losses and to improve the health, disease-resistance and quality of adult animals.

More natural systems of rearing, less forcing of young stock, a good use of good-quality, fresh home-grown food-stuffs, and a restriction in the use of manufactured compounds containing by-products from imported seeds, would effect improvement in health and constitution in all species of young stock."

595. Deterioration due to faulty feeding :

"There is much evidence that modern methods of 'scientific feeding' are producing a cumulative deterioration in the health of farm-animals. It is difficult to particularize ; but the increasing annual wastage in the dairy herds, (now over 25 per cent), the rising incidence of sterility in cows and bulls, of mastitis, digestive troubles, and general metabolic disturbances in all classes of farm live-stock and most paralysing effects of mortality in poultry kept on the intensive system, point to deficiencies or inaccuracies in the present regimes of feeding. Without doubt, some of these troubles can be traced to the excessive use of imported vegetable proteins, specially from the tropical oleaginous seeds, after removal of the oil"

"Unwise and faulty animal-feeding leads not only to a lowered general resistance to disease, but it results in the production of human food-substance of less than perfect nutritional value."

Our farmers in India without the aid of scientific laboratories knew much about animal-feeding and animal nutrition by observation and intuition. But all

that has been levelled down to a common phase of ignorance. The steam roller of Western science has not left any field reserved for respecting the usages and practices of those who knew how to build a strong and efficient herd. There is a reaction setting in England against too much dependence upon artificiality in animal-breeding, and more and more emphasis is being put on natural ways of cattle-management. Things there are that science could not explain and are, therefore, ignored. The newer knowledge of nutrition is for re-establishing those natural methods. More virtue is seen now in things which appeared to have no special value before.

596. Importance of grass and grazing : Mr. Miller then went on to describe the deficient feed that the cattle are receiving because of the "lack of knowledge of many of the fundamental details of grass-land management which farmers should possess."

"It is impossible to over-estimate the importance of grass and grazing on animal health. No method of artificial in-door feeding ever gives results, which are comparable with those obtained by proper use of good grazings, and there is adequate evidence to show that correctly-managed grass land is one of Britain's richest natural resources for the production of healthy fertile stock, yielding products of the highest nutritive quality."

The pastures are not to be left to themselves with unlimited grazing. The stocks-man has to guard against the 'sickness' of the grass land. The address put stress on this aspect of the matter and showed how

real improvement required the co-operated action of all scientists.

“The work entails the co-operation of botanists, plant geneticists, soil experts, agriculturists and veterinarians, and the improvements possible would amply repay the sums needed to finance adequate research.” (396, 424-'39, 981-'82)

597. Contact between student, soil and farm animal: Not only this, Mr. Miller called for a change of outlook on the part of his people: “Field stations are urgently needed, so that fuller immediate contact between the student, the soil and the farm animal can be achieved.”

The Indian veterinarians have received their heritage of training from British practices, and the address can be regarded as a strong appeal to change the aspect of the old heritage in which the horse was the central figure in the animal world of the veterinarian.

“The bias towards the horse (and more recently to dogs and cats) should be changed, and the food-producing animals should receive the major amount of attention.” (15, 27, 570-'82)

598. Knowledge about Indian fodder: The nutrition of the cow in India offers difficult problems, all their own. In matters of health and nutrition and selection of fodder, based upon their chemical composition and digestibility, Indian research work is lagging very far behind. Digestibility trials on Indian fodders are just beginning to be made. Some materials have already accumulated, but much more is necessary. Yet, with what little has been

known of Indian fodders, enough has come to hand to enable us to form policies for drastic changes in the nutritional methods now prevailing in the country. Knowledge so far accumulated in India or in South Africa or in other tropical countries, in so far as they are applicable to India, may be utilised, and much of the mal-nutrition stopped.

599. A little correction in nutrition may bring in immense welfare : The importance of the subject of animal-nutrition cannot be over-emphasised. A little change here, a little correction there, may bring about remarkable results, and also help to solve to some extent the general problem of fodder-deficiency, by creating an enthusiasm for improvement within reach of the cultivator, which he had not been taking up, for his want of initiative and knowledge.

Regarding the value of balanced diets it has been long known that the more it is consumed, the better nourished will be the animal with reference to which the ration is balanced, up to the point of repletion of its requirement. On the contrary, if the rations are unbalanced "the more of them are consumed the poorer nourished will be the animal with reference to the functions with respect to which the rations are unbalanced." In such cases, simple doses of corrective might make enormous changes. It had been demonstrated long ago that the mere inclusion of one per cent of sodium chloride in a ration, predominantly made up of corn, increased its growth-prompting value by 40 to 50 per cent in feeding experiments with rats and chicks.

CHAPTER XVII

PLANTS AND ANIMALS

600. Plant-life supports animal life : Animals depend for their nutrition upon the plant-world. The two creations go side by side. Where there are no plants, there are no animals, and the place is a desert. If one could make an oasis of a desert, provide for the growth and development of plant life, then animal life will automatically follow. There are some animals, the carnivorous ones, that do not live upon plant or herbage. They devour other animals. But following the chain of feeds it will be found that the animals devoured are dependent on plant-life for their existence. The carnivorous animals, therefore, also depend on the plants, indirectly, for their existence. Under water, under the bottom of the sea, go wherever you like, it is plant life that supports animal life. And strangely enough, the life process is the same in the animals and in the plants. Both have mechanisms or organs for growth, development and reproduction. The reproductive process is also amazingly similar. There is the ovary of the females, the sperm of the male, and the two combine to form a new plant. There is reproduction by the process of division in the animal world as well as in the plant world. In fact, it is difficult to say which is more developed, the animal or the plant in the mechanism

for growth and development. The plants are one step in advance of the animals in the matter of nutrition. The animals depend on plants for existence and for their nutrition, while the plants depend directly on the soil and the sun for their existence, and draw their sustenance from these primary sources. Sunlight is also necessary for animals but not to such an extent as in the case of plants. Out of a seed put into the soil the plant grows and develops. Similarly, out of the composite thing—the ovum and sperm—the animals grow. For the cow, we are, at every step, dependent on the plant, be it fodder or be it concentrate; it must come from the plant. Ultimately, both plants and animals on the final decomposition of their bodies give back to the sources the elements which they drew from them to form their bodies.

601. Burning a plant: If we take a plant and set fire to it, the plant burns. After the plant is burnt out most portions of it is seen to have disappeared. Just a little ash remains. Where has the large bulk of the plant gone? To the air, of course. And where is the ash left? On the earth. The plant body has been resolved to its components by fire; and the airy component of the body has gone to the air and the earthy component to the earth. The plant builds its body mainly from the substance of air. It does take some material from the earth, but that forms a very little portion of its body. After burning a plant, ashes are only left and these are the contribution of the earth to the plant along with some water which has disappeared during burning by the heat but would

return to the earth, sometime in the form of dew. It is true though hard to believe that 80 to 90 per cent of the wood-structure is practically built from the air.

602. Contribution of the earth to the plant :
ashes : Whatever be the contributions of the earth and the air for building the plant body, the importance of both the components is equal. Without air the plant will not grow, nor without sun-light. Similarly, without the earth constituents the plant will be unable to build up its body. Plant life, the living composite organism of it, under the influence of sun-light, decomposes the air and takes nutrition from the air. The same life-process draws some materials in a soluble form from the darkness of the soil. The combination of these two kinds of materials from the air and the soil is the plant with the added energy of the sun. When the plant burns, it returns the energy of the sun in the form of heat, and we may measure the doses of sun's heat that a plant took to build up its body by measuring the heat of its combustion. In the plant the leaf and its green matter, the chlorophyll, play the wonderful part of resolving air and sucking up nutrition under the influence of the sun. The root performs the wonderful part of sucking nutrition from the soil under the influence of water or moisture.

In order to know the process involved in the growth of the plant, we shall have to make the acquaintance of the materials that come under the plant-building process and the ultimate constituents of those materials.

603. Plant-body made of cellulose : We say that the wood-body is made of cellulose and that cellulose is a *carbohydrate*. There are other substances in the woody core and bark and leaf of the plants, but the main substance is carbohydrate. This word carbohydrate need not baffle us. Carbohydrate is a complex substance consisting of carbon, hydrogen and oxygen. We always meet these elements about us in the form of compounds whatever name we may give them. In fact, to our left and to our right, above and below and within us, these ubiquitous elements—carbon, hydrogen and oxygen—are present.

604. Plant-carbon from the air : Carbon is the substance of wood charcoal. The impurity of wood charcoal is the ash substance of it. Pure carbon will leave no ashes on burning. The hydrogen and oxygen we meet most readily in water. Water is made of oxygen and hydrogen, which are gases in a free state. By the union of hydrogen with oxygen the gaseous character of both these substances disappears, and we see them combined in the form of water. Water may take a solid form by freezing under the influence of cold and may again take the form of vapour under the influence of heat or of air. If we keep water in a dish, it gradually disappears ; it dries off in the form of moisture and vanishes on the wings of the air.

605. Oxygen, nitrogen and carbon of the air : Oxygen is also a component of the air. Air is a mixture of nitrogen and oxygen and just a little of another substance, carbon-dioxide, a gaseous combination of carbon and oxygen. Air then is a mixture of these

three substances—oxygen, nitrogen and carbon-dioxide. Nitrogen in a free state is a gas. Carbon-dioxide, a combination of carbon with oxygen, the product of burning wood, is a gas. These three gaseous substances form the air.

606. Carbon-dioxide to wood ; We have now got a clue to where the plant gets its wood-form from. We have known that there is carbon-dioxide in the air. The leaf of the plant decomposes the carbon-dioxide of the air under the influence of the sun's rays, and through the agency of the green colouring matter, chlorophyll, absorbs carbon from the air and transforms it into carbo-hydrate by its peculiar life process. Carbohydrate needed the three elements, carbon hydrogen and oxygen, to form it. The plants get the three elements from the air and moisture. The moisture is in the soil. Plants draw upon this source for their purpose, through their roots.

The plant-body is mainly composed of woody material and we have traced the woody material, the main portion of it, to its sources—the air and moisture. (631)

607. Protein in the plant : Another substance of importance in the plant-structure is protein. Proteins contain nitrogen besides carbon and oxygen and hydrogen. Nitrogen, as we know, is in the air. It is a very inert material. It refuses to come into combinations readily. Plants have some special mechanism for combining it. Plants get their nitrogen from the soil where it goes from the air through the agency of some bacteria.

There are certain plants which have the property of fixing nitrogen from the air and transferring the nitrogen to the soil through their roots. (846) The leguminous plants are particularly adapted to this work. But it is not the leguminous plants alone that play this function. Other plants also do it. The rice plant, for example, has such a mechanism and so have the algae. The nitrogen of the air in the first instance gets fixed in the soil through the action of plant-bacteria ; and the generality of plants draws nitrogen from the soil into their body, particularly in the leaf-structure in the form of protein or a crude form of protein. (616-'17, 622, 657, 699, 724, 844)

608. Various proteins : Readers are familiar with a few forms of protein. Milk contains it and when fat is separated from the milk and the skimmed-milk is treated with acid, the precipitated substance is milk protein. It is an animal protein. This milk-protein in a dry and powdered condition is called casein in the trade. It has got many industrial uses. It acts like glue if dissolved in borax and is a very superior binding material.

When wheat-flour is made into dough and that dough is puddled with water, starch granules get washed away. What is left is called gluten, a sticky material, also used for joining wood to wood like glue. This gluten is a plant-protein. The flesh and skin substance of animals is also protein. We have traced the origin of protein to plants which draw carbon from the air and nitrogen and water from the soil, and manufacture it.

609. Minerals in plants : We have accounted for two substances in the plant organism—carbohydrate and protein ; and there is the third group of substances which we know by the name of minerals. The first two items cannot form the plant-body in the absence of these minerals. They are required in very minute quantities, but they exercise a profound influence on the growth and development of plants. Their names are various, but the principal ones are calcium, phosphorus, potassium, sodium, and magnesium. (702, 712)

610. Calcium in plants : The mineral substances are in the soil in combination with other elements. We should get a little more acquainted with them. The shells consist mainly of calcium. When shells are burnt lime is obtained. Lime is also in the soil in the form of chalk, *kankar* or calcareous earth. Calcium, like other minerals, goes from the earth to the plant, and from the plant to animals, and when the plants or animals die, they are returned to the earth again. The bones of animals contain calcium to a very large extent. (612, 708, 714-'22, 774)

611. Phosphorus, potassium, sodium in plants : Phosphorus is the substance which has the property of glowing in the air. The glow-worm glows because of its phosphorus. Phosphorus in combination with other elements makes the earth. Some plants and weeds are particularly rich in potassium. Sodium is also an important component of plants. The most familiar form of a sodium compound is common salt, called sodium chloride, a substance profusely present

in sea water. The soil also contains it. There are other mineral substances besides these.

The plant collects these elements in its life-process and manufactures them into body-substances. (714-'22)

612. The vitamins : The vitamins are other life-giving substances, which occur in the minutest quantities, but which are of immense importance in weaving the structure of living things out of their component elements. (610, 709, 750-'61, 862, 872-'74, 1115)

613. The seed—a store for future life : These four materials may be regarded as the foundation of plant nutrition, or necessary for the formation, growth and development of plants. Plants are designed to propagate, and the most common propagating mechanism is the seed. In the seed, the plant stores up the essentials of the future plant-nucleus. When the seeds, in the proper season, come in contact with moisture and air and the warmth of the soil, they germinate. The life that was sleeping in the seed blossoms forth into a new plant structure. The seedling is a weakling, and fore-seeing this, the parent-plant had not only imparted the life principle to the seed but used the seed as a store of food for the coming plant in its early days.

614. Seeds supply starch : We know that plants require carbohydrates, proteins and minerals and the vitamins to form their bodies. These substances are necessary for the new life that would come forth, and the parent-plant, therefore, stores these substances in the seed. The seedling, on coming out, utilises this

store of nutritive substances and shapes its structure out of them. The root goes down seeking nutrition from the soil and the shoot goes up seeking nutrients from the air. All this time, the seedling feeds upon the stored material in the seed to shape its roots and shoots and leaves. By the time the roots, shoots and leaves are capable of functioning, the seed store gets exhausted and is not needed. It is in the seed, therefore, that we find the entire plant-substance in a concentrated form.

615. The oil of seeds is a compound of carbon, hydrogen and oxygen : Oil is a complex compound of carbon, hydrogen and oxygen and is combustible like carbohydrates. The young or baby plant needs oil before it can manufacture oil out of its elements or the carbohydrates. Therefore, the seed has to contain oil or fat substances. Some of the seeds are very rich in particular substances for the particular necessity of the out-coming plant. Men know which is which and have been utilising them. Those seeds in which the carbohydrates are very plentifully stored we call cereals, such as rice, wheat, barley, *bajra*, maize, *ragi* and other millets.

616. The pulses largely store protein : Those seeds in which proteins are largely stored we call pulses, such as the various peas, the cow-pea, the pigeon pea, the field pea, lentil, gram, etc.

Those seeds that contain a large proportion of oil we call oil seed, such as mustard, rape, *til*, linseed etc.

Minerals and vitamins are found in all seeds. (607)

617. The protein of oil-cakes : When the oil seeds are pressed, the oil goes out, making for the supply of oil. What is left behind is oil-cake. Oil-cake consists of the cellular case of the seed, holding all the proteins and minerals of the seed. On this account, both for its protein and for its minerals, the oil-cakes are particularly valuable food both for the soil and for the animals. (607)

618. Plants store tubers : The seed, however, is not the only store-house of the plant. The carbohydrates in the form of starches and sugars are stored in some roots. The plant-body itself is principally cellulose, a form of carbohydrate. *Proteins* are stored in the leaves. Of course, these storages are poor compared with the perfection of storage in the seeds. In the seeds all the requirements are stored up in life-giving proportions. The tubers of some plants hold large stores of carbohydrates in the form of starch. These are used as food both for cattle and men.

619. The nutritive mechanism of the cow : Having learnt something about the plant, we may now proceed to consider the digestive mechanism of the cow and the nutritive materials necessary for the cow.

The plant can manufacture carbohydrates, fats and proteins and also some of the principal vitamins out of their elements from the air, the sun-light and the soil. An animal cannot do quite as much as that. The stomach of the ruminants, of which the cow is one, is made particularly suitable for the ingestion of a large quantity of herbage. Nutrition must materially and in a major portion come from the

herbage. What the plant can do, the cow cannot. The cow cannot, for example, take carbon from the air, swallow some earth from the soil, and with water make carbohydrates out of them. The cow-body is not constructed for that. The cow can take and digest herbage, and in a normal and natural condition it subsists entirely on herbage, i.e., on the carbohydrates, proteins, minerals and vitamins that she may extract out of the herbage through the process of digestion.

What the cow, a ruminant, can do, a horse cannot. Their stomachs are differently designed. The horse also obtains the carbohydrates, the proteins, the minerals and vitamins from the plant. The horse cannot synthesise or construct these out of the elements as plants can. But the horse cannot even do what the cow can, i.e., digest all the herbage that goes to feed the cow. The stomach of the horse would not be able to work with as much herbage as the stomach of the cow. The horse has a smaller and differently-constructed stomach. The horse requires more of concentrated food and less of herbage than the cow.

A cat or a dog cannot, however, perform what even the horse can. Their stomachs are still smaller and, therefore, they need more concentrated food. Man stands between the herbivorous animals and the carnivorous animals. The stomach of man can tolerate more herbage than that of a dog or a cat but not quite so much as that of a horse or a cow. Man requires some herbage in the form of vegetables and mostly concentrates in the forms of cereals, pulses etc.

620. The essentials of nutrition ; same for plant and animal : For plant or cow or horse, cat or man, the essentials or foundations of nutrition are the same four-fold items : carbohydrate, protein, mineral and vitamin. The carnivora require protein most. From protein they meet those requirements which men or cows do from cereals and herbage which also contain protein. The carnivora, therefore, have to depend on animals, on animal meat in the form of protein, which is their principal but not sole source of supply of nutrition.

621. The sustaining structures of wood and bone : The cow takes carbohydrates, proteins, minerals and vitamins from the grasses and other fodders, and converts these into their body-substance. Although the cow takes every item of nutrition from the plant, there is a great deal of difference between its nutritional requirements and of the plant. The plant-body is chiefly carbohydrate and the sustaining-structure is wood or cellulose—a form of carbohydrate. As wood supports the plant-body, so the bones support the animal body. Over the woody inner structure, there are the bark and foliage containing just a little protein but principally carbohydrate again. In the cow, in the structure of her bone, consisting of minerals there are flesh and skin both principally proteins. They also contain a good portion of minerals in them. Therefore, while the plant structure is mostly of carbohydrate with some protein and mineral, the animal structure is principally of bone or minerals and proteins. Bones are practically

made of the minerals, calcium and phosphorus. In the hollow of the bones there are proteins. But devoid of this substance in the hollow of the bone, the bony structure proper is practically made wholly of calcium and phosphorus. When the bone is burnt, what is left as ash is almost pure calcium-phosphate, a compound of calcium and phosphorus.

622. The bone has more minerals and proteins : It will thus be apparent that the animal structures have more of minerals and proteins ; the carbohydrates take a place of much less importance in the animal as compared with that of the plant.

If the cow is, therefore, to construct its body out of herbage, it has to make selective use of the constituents of the herbage, not in the same proportion as they exist in the plant but in different proportions. It will also be apparent that herbage contains too much of carbohydrates, much more proportionately than the cow can need to build her body. (607)

623. Disposal of carbohydrate by the cow : What is the cow to do with this excess of carbohydrate mixed with so little protein and minerals as these exist in the plant ? Herbage is the chief food of the cow, and what she has to build is a structure of minerals and proteins out of a stuff which is poor in mineral and protein but rich in carbohydrates. Why has nature designed herbage as the food for the cow, and how is the cow to eliminate from her system the carbohydrates which she has got to ingest in her search for the minerals and proteins, her principal requirements ?

We need not be anxious. Nature works unfailingly for its objective, and we have only to find out the meaning and the purpose of her ways. Presently, we shall see that carbohydrate has a great function to perform in the life-process of the cow, although for her body-building she need only have a little of it. (658, 683)

624. The cow has to search for food: It will not do for us to over-look the functions of the two, the plant and the cow. In plant-life the only objective is to build itself and procreate by standing at one place. The cow has to go about in search of food for the same objective of body-building and procreation or to maintain life and function fully. A difference is thus forced upon the cow by nature, of having to search for her food.

625. The plant stands rooted to the soil: The plant gets all its needs by standing at one place. This is a very material difference. The plant stands rooted to one place. The roots branch out and collect a part of nutrition, nitrogen and minerals in a soluble form from the soil. The plant shoots up and branches out in foliage. The leaves are the converters of the carbohydrate of the air into the carbohydrate of the plant-body. Food below and food above surround the plant. The plant has not to go about searching for food. Air functions there by giving the plant doses of carbon from its carbon-dioxide and then moving away in the form of breeze and allowing fresh air to be consumed by the leaves. The air is moving day and night past the leaves, while

the leaves are immersed in the air. Food is cheap for the plant. The roots have to undergo little effort; they are to spread out for having access to ever-new surfaces of the earth for sucking up nutrients.

626. The cow spends energy by moving : There is no locomotion in the plant. This stands as the biggest differentiator between the plant and the cow. The plant stands quietly and functions for its maintenance and growth, while the cow has to walk about to get her feed from the pasture. Moving about or locomotion is the extra thing that the cow does, as compared with the plant. Moving about means the spending of energy. The cow has to spend energy, and draws upon the excess of plant-carbohydrates which she has to ingest to form her body. Here is a noble use of the excess of carbohydrate that the cow has to take.

627. Energy creation and food : In order to understand this relation between work or the energy of moving and the feeding on carbohydrate as a source of that energy, we must go into the mechanism of the conversion of carbohydrate into locomotive energy. The plant gives more carbohydrates than minerals to the cow. The cow uses all this carbohydrate. We have found that this feeding on carbohydrates by the cow is a necessity for the work which the cow has to do to move about for its food. For the moment we shall forget the plant and take up the cow as an instrument for the conversion of carbohydrates for its purpose of moving about.

628. Burning or combustion of carbohydrates in the system : The cow ingests carbohydrate in its food which cannot go to build its body as its body does not consist so much of carbohydrates as of proteins and minerals. This carbohydrate the cow ingests and then burns it within her system. Tracing the origin of the carbohydrate in the plant we come to the air. Air contains the gas carbon-dioxide. The plant extracts the carbon out of the carbon-dioxide and releases the oxygen into the air. In the animal body the reverse phenomenon takes place. The carbon ingested with the carbohydrates combines with the oxygen of the air in the body of the cow and produces carbon-dioxide. Animals take the air inside their system and the oxygen of the air is extracted within the animal-system and made to combine with the carbon of the carbohydrate. The inhaled air is pure air. The exhaled air is air loaded with carbon-dioxide. The plant through its leaf also inhales, so to say, air. The leaf absorbs the carbon of the carbon-dioxide of the air and returns the air poorer in carbon-dioxide and richer in oxygen. That carbon had gone to form the carbohydrate in the plant.

629. Establishment of carbon balance in the atmosphere : It was time now to discharge the loan of carbon taken from the air for the formation of carbohydrate in the plant. Animals burn the carbohydrate within the body with the help of the oxygen of the inhaled air, reproducing carbon-dioxide within the system, and then they return the carbon-dioxide

to the air. The carbon returns to the air through the cycle of plant and animal. Plants denude the air of something, and that something is returned to the air by the animal which had ingested the plant. A balance is thus established in the air. This course is not the sole way of the disposal of the carbon accumulated in plants from the air. All wood and herbage do not go through the animal stomach. But, ultimately whenever wood-matter is decomposed a state equivalent to the combustion of the carbon of the wood takes place and returns to the air as carbon-dioxide.

630. Wet combustion of carbon : Within the body of the cow the process that goes on day and night by the mechanism of digestion and of breathing may be called combustion. It is wetburning. But the ultimate result is the same as in dryburning in the air. In burning a piece of wood we get a lot of heat generated and find that carbon-dioxide is produced which escapes into the atmosphere. In the combustion within the body of the cow, the carbon is burnt. Whenever carbon (as carbohydrate or fat) burns, carbon-dioxide will be produced and heat will be generated. The fact that carbon-dioxide is produced within the cow and exhaled out with breath can be easily proved. Exhaled air, be it from a cow or from a man, contains carbon-dioxide produced through combustion. (682)

631. Test for exhaled carbon-dioxide : If lime is shaken with water and allowed to rest, a clear liquid stands at the top after the milky mass has

settled down. This clear water is called lime-water. Lime-water has the property of absorbing carbon-dioxide and of converting the absorbed lime into calcium carbonate or chalk. If clear lime-water is separated out and put into another tumbler and breathed upon, the clear liquid will become milky by the absorption of the exhaled carbon-dioxide. We know that air contains carbon-dioxide, however little. The presence of carbon-dioxide in the air can be detected in the same way by keeping a little clear lime water exposed to air. After a time there will be formed a white crust on the top of the clear fluid. This white crust on the top of the clear fluid will readily break and settle down. This crust is of calcium carbonate or chalk formed by the combination of the carbon-dioxide of the air with lime water. (606)

632. Combustion produces carbon-dioxide and heat : Whenever carbon burns in the air not only is carbon-dioxide formed, but heat is evolved. The amount of heat is proportional to the carbon consumed or burnt. An exact measure of the amount of heat evolved can be found out. The same amount of heat is evolved by the combustion of the same quantity of carbon, whether the combustion takes place in the atmospheric air or inside the animal body. A definite amount of carbon-dioxide also is formed by the combustion of carbon, whether the combustion takes place inside the body or outside in the open. By measuring the carbon-dioxide a measure of carbon and of heat can be found out. It has been definitely established that whether carbon burns outside or inside

the body, the same amount of heat and carbon-dioxide is evolved.

We may burn carbon in a stove, say charcoal, or we may burn carbon in the form of oil, a hydrocarbon, in a lamp. The result is the same, being the formation of carbon-dioxide and the evolution of heat.

633. Heat of combustion : The evolved heat may be utilised for boiling water or heating some other substance. Men may utilise heat for the production of some work by employing proper appliances. Heat is a form of energy and heat-energy may be converted into work. This is what happens in a steam-engine or in an oil-engine. The steam-engine has a boiler attached to it. The heat of burning coal or wood is utilised for boiling water and making steam. The steam is made to propel the engine. The steam itself gets cooled down to water after it has given up its heat in the form of work—driving the piston or the wheel of the engine. The engine is a converter which converts heat-energy into work or motion. Under the impulse of steam the engine moves. At the root of the motion, there is heat as the cause of it. Similarly, in an oil engine, oil is burnt within the engine and the heat produced is converted into work by the movement of the piston of the engine and then of the wheel. Here again, heat-energy stored up in oil is liberated and converted to work. In either case, in the case of the steam-engine or the oil-engine, if an account is kept of the amount of carbon-dioxide formed, then the quantity of coal or wood consumed can be ganged and *vice versa*

if an account is kept of the weight of the carbon burnt. The amount of carbon-dioxide and heat produced can be determined, for the proportions are definite.

634. Conversion of heat of combustion to work :

A cow when she burns carbon in her system also behaves as an engine, producing a definite amount of heat and carbon-dioxide. The heat she utilises for keeping her body warm and for her life-function to go on in work inside and outside the body or through the body. When the digestive organs move in the stomach a certain work is performed. It is performed out of the heat of combustion of the fodder-material. When the cow breathes, there is inhalation of air, the heaving of the chest and then falling of the chest and exhalation of air. All these are items of work. When the cow moves her body or swings her tail, or shakes her head or walks, she performs work at the expense of the heat of combustion of carbon of the digested herbage.

635. Herbage enables the cow to build the body and to work : Here, we have now found the explanation as to what had the cow to do with so much carbohydrate of ingested herbage, which she could not possibly utilise for her body-building. We now understand that by the ingestion of herbage the cow is not only able to build her body but also to perform work, in the shape of internal work or processes involved in mastication and digestion etc., and the outer work of movements.

636. Synopsis of the fundamentals of nutrition :

By now we have stepped on the threshold of a new

phase of the problem of nutrition. So far, by analysing plant and animal life, we have come to the following conclusions :

(1) The plant synthesises within itself carbohydrates, fats, proteins, minerals and vitamins into its body substance from their elements, gathered from the soil and the atmosphere ;

(2) Carbohydrates and fats are made mainly from the air and constitute the major portion of the woody structure ;

(3) Plants make protein with nitrogen from the soil, which nitrogen again finds its way to the soil through plants ;

(4) Minerals enter into the composition of the body-substance of the plant and are obtained from the soil ;

(5) The cow ingests carbohydrates, fats, proteins and minerals from plants and builds them into her body-substance. For building her body she requires very little of carbohydrates. The major portion of carbohydrate which she ingests goes to supply her the energy for performing the internal functions of digestion etc., and for performing the movements of her body and for doing work.

We shall now step on to the next stage, that of the maintenance-requirements of the cow, of the four-fold nutritional foundations, namely, carbohydrates and fats, proteins, minerals and vitamins.

CHAPTER XVIII

TRANSFORMATION OF FEED

637. In the last Chapter it has been mentioned that the plant synthetised carbohydrates, proteins, minerals and vitamins in its body and the cow gets these by feeding on the plants. These are the four foundational nutrition materials.

It should not be supposed that the cow utilises them in the same state as they were in the plant. Although the body of the cow contains all the four foundational nutrition substances, yet they are quite different from the plant materials. In animals carbohydrate is in a different though allied form, and as has been said, they constitute an insignificant portion of the animal body-structure contrary to their place of predominance in the plant-body. The animal takes its proteins from the plant but manufactures new protein-substances out of those materials; and **what** is finally found in the animal body is flesh and nerves or milk, i.e., animal proteins different from plant-proteins. The minerals are interwoven with the proteins and various other substances. The cow gets the raw materials from plants and then remodels them into her body-substance. This remodelling of food materials under the influence of the life-process is called metabolism. The calls on metabolism are many-sided and various. Suitable food materials under the influence of the life-process respond wonder-

fully to the calls, yielding complex substances for the various requirements of building, repairing, functioning and working.

638. Herbage builds the cow body : The cow-body consists of bone and skin, of hair and hoof, of the internal organs of digestion and circulation, of the nervous system and the secretory systems etc. All these have to be built from the herbage and other feeds offered her. But this (a) *building operation* is only a part of the duty or requirement. Building goes on from birth up to maturity. After that, building proper ceases in normal, well-developed, healthy animals. But along with building work (b) *repair work* has to go on. The body substances decay by daily use of them, and to the extent they are worn out, decayed and excreted off, repair work has to go on to keep the system in a fit, repaired and workable condition. It is, therefore, that (a) building and (b) repair work have to go on side by side.

639. The feed provides for internal and external work : In order that the body may be built the internal organs have to work. The mechanism of breathing and circulation, of digestion and excretion, has to be kept running and for this purpose (c) energy in proper form has to be created by the individual.

In order to live it is necessary for an animal to do some *external work* ; some movements have to be performed and this again requires (d) energy to be evolved out of the feed. These are the four-fold calls, (a), (b), (c), (d), that the animal has to satisfy out of the feed in order to grow and function properly.

640. Combustion of blood : Of the four items (c) and (d) are energies and these energies are to be obtained from food, first by metabolism of food and then by the combustion of the metabolised food. Animals have only one medium of combustion. If we have a kerosine stove, we cannot burn coal in it. Every time we want heat we must feed the stove with kerosine. In the animal the final burning material is blood. In order to burn, the material must be carried to the blood stream, and in the blood stream it will burn, forming further degenerate products in the blood, one of which is carbon-dioxide. The spent-up material forms carbon-dioxide, even if the combustible materials were burnt outside. The blood has the power to absorb this waste product and carry it to the lungs, where the carbon-dioxide is thrown out with exhalation and the blood gets rejuvenated with oxygen from the inhaled air which it has the power of absorbing. We shall have the details of this mechanism when considering the body-structure of the cow in Part V (Vol. II). In the combustion for the production of energy along with the carbon-dioxide other degenerate products are formed which find their way out of the body through the excretory organs of the intestines, the kidneys and the skin.

641. Blood builds and repairs : For the functioning of the item (a) and (b), i.e., for body-building and repair, the requisite substances must also pass into the blood stream. It is a delicate work, this passing of food materials into the blood stream, Blood is a fastidious substance, having a close range of standards

of its own. In order to function properly the blood must remain within its own close range. If the blood is artificially loaded with substances which fall beyond this range, it will not be able to function properly, and mal-nutrition or disease or disaster will follow. All the time we see the cow nibbling grass or chewing the cud, the blood-stream is doing its work and getting replenished and rejuvenated by the food materials that are being sent by the mouth to the stomach for digestion, and ultimately its useful and acceptable parts are thrown in desirable condition into the blood-stream.

We shall first take up the consideration of the two items (c) and (d) involving the production of work, and later on take up (a) and (b) building and repair.

642. Combustion of blood sugar : Whenever work is performed blood is burnt. Blood contains a limited amount of sugar in it. Sugar is a soluble form of carbohydrate. This sugar is produced from the various forms of carbohydrates taken in. Carbohydrates may be presented to the cow in the form of cereals, pulses, oil-cake or leaf or root. All these, after metabolism, will have to be put into the blood stream. A certain amount of carbohydrate is kept in reserve in the liver. As the sugar of the blood gets exhausted by work, the liver goes on adding doses little by little to keep the supply replenished.

The capacity of the liver to store up carbohydrates is very limited. The body needs the keeping of some reserve of carbohydrate for an emergency. Here, in the matter of storing, the animal body functions partly

like the plant body. The usual storage-place of carbohydrates in the system is the liver. But this being not enough for emergency purposes, some other forms of storage have to be brought into existence. This the animal does by converting carbohydrates into fat and depositing the fat in the various parts of the body, principally as a lining under the skin. In emergencies when the liver storage may run short, this fat is drawn upon to supply energy. Fat also contains carbon, hydrogen and oxygen like the carbohydrate from which it is manufactured in the animal-body,

It will not be out of place to mention here that the body of the cow needs some fat, which has to be fed. It is better placed if a quantity comes to it through the cereals and oil-cakes. The cereals contain a good amount of fatty substances in their sperm. Oil seeds, of course, contain it. It has been observed that small quantities of oil or oil-cake can splendidly furnish the requisite need. We generally look upon carbohydrates as the source of the supply of energy. But protein also burns. When carbohydrates are wanting, and yet there is need of combustion, the system draws upon the proteins of the body to carry on the functions. As protein gets burnt the body gets emaciated and its weight is lost.

It is costlier for the body to form the protein substances within it. Therefore, it is bad economy to allow the protein to be burnt. But necessity forces this to be done. On normal occasions also, this costly material is burnt. If more protein is fed

than there is necessity for, or than can be added on to the flesh, the excess burns away like carbohydrates. This burning of proteins taxes the internal organs. It produces more than ordinary poisonous excretory materials, and entails abnormally hard work on the kidneys.

643. Internal and external work : By burning carbohydrates and proteins, the body is enabled to perform both internal and external work.

For items (a) and (b) (638) for building and repair work, protein is the material. Protein-substances get into the blood stream and do their daily share of replenishment work. When body-building is necessary, the requisite quantity passes on through the medium of the blood to be converted into body-tissue. The four-fold work of body-building and repair of internal and external work are, as we have seen, performed by the ingested proteins and carbohydrates.

644. Minerals and vitamins take part : Although no mention has been made of the minerals and vitamins in this connection, yet it must be understood that the proper doses of the various requisite minerals and vitamins must be supplied with the feed. In their absence, the blood will fail to have its characteristic. Feeds without them will work as a burden, worse than a waste. The minerals and vitamins, however, have little burning value. But it will not do to dismiss them. Again, water and air, although no mention of them may have been made yet are requisites for (a) (b) (c) (d) along with minerals and vitamins.

The stock will fail to digest herbage not containing the proper minerals and vitamins despite the ingestion of the necessary proteins and carbohydrates. They will not be able to live without the proper doses of these substances. They are no less vital necessities than proteins and carbohydrates. We shall learn gradually that their importance is greater. Here, this much only is to be understood that the contribution of minerals and vitamins as combustible substances for the production of energy is negligible.

645. Consideration of energy-requirement : We have up till now laid stress on the four-fold foundations of nutrition. Now, this fifth matter, the question of the production of energy, has got to be taken into account and its implications understood.

The more work an animal does, the more energy it spends, the more energy-producing materials will it require to be put in its feed. If all work is stopped, if moving about is also prevented, still there will be a residuum of energy necessary to keep the life-process going and to keep the digestive system working. In order to keep the system working carbohydrates and proteins will have to be burnt. Such combustion also will produce heat. It will be dissipated through the skin, a portion only of it contributing to keep up the body-heat.

When all outside work is stopped, the residual requirement of energy which must be supplied to an animal to keep it alive without losing weight is called basal metabolism. This is determined scientifically in order that, upon this basis, the calculation of energy

for growth, for milking and for work and for carrying the foetus etc. may be worked out.

646. The unit of energy : The amount of energy necessary to raise one kilogram of water to one degree centigrade is called a **Calorie**. A thousand Calories go to make a 'Therm'. A Therm is the unit for energy measurement. There is a small caloric spelt with a small 'c' which is the measure of the heat required to raise one cubic centimeter of water to one degree centigrade.

There is another way of expressing energy-requirements. It is expressed in pounds of starch. That much of heat which is evolved by the combustion of a pound of starch in the animal system is taken as the unit, and is called "Starch Equivalent," or simply S. E. If one hundred pounds of a kind of fodder produces after digestion as much heat as will be generated by feeding or by combustion of 22 lbs. of starch, then the S. E. of the fodder would be 22.

It has to be pointed out that the "Starch Equivalent" is the net energy value of the feed or the amount of energy left after deducting from the metabolised or available energy, the energy lost in the work of digestion. The metabolised energy is not the inherent heat-production capacity of the substance. The heat produced on burning a substance is its gross energy. Just as in coal, the gross energy value of a feed is determined by burning the feed in pure oxygen in a calorimeter. But this energy will not be evolved in the animal system because of incomplete combustion or digestion. Gross energy, therefore, does not

indicate the nutritive value of feeds. Substances giving the same units of heat in a calorimeter may behave differently in the matter of energy which it can furnish to the system. For the consideration of nutrition, the gross energy-value has to be reduced by loss due to indigestibility, as passed out in the faeces and urine, and the losses due to the formation of useless combustible gases. What is left is the *available energy* or metabolised energy. All this available or metabolised energy does not go to perform work. There is loss due to the work of digestion. What is left after accounting for the loss during the work of digestion is called *Net Energy Value*. The Net Energy Value of starch is that value which will be left available after all these deductions. S. E. Value, therefore, is the net energy value. The following equation will make the definition clearer :

Gross energy value—Minus energy lost in faeces,
urine and in combustible gases
formed :

= *Metabolised Energy or Available Energy.*

Metabolised energy—Minus energy lost in the work of digestion is *Net Energy*.

A protein may show much higher gross energy than starch, but in breaking it up in the body, for the production of heat, much energy is lost. Eventually it may show less net energy than starch. (676)

647. **Relation between Therms and S. E. :** There is a simple relation between the two units, the Therm

and the S. E. If the *S. E.* figure is multiplied by 1·07 then the product gives the *Therms.* For example, *Therms* corresponding to 15 S. E. would be $15 \times 1\cdot07 = 16\cdot25$. Similarly, if energy is known in *Therms*, it can be converted to S. E. by dividing the *Therms* by 1·07. In Great Britain they express energy in S. E. units. In America, they express it in *Therms*. There is no difficulty if we remember that the two are very nearly equal and that S. E. is equal to 1·07 *Therms*.

It has been mentioned that proteins also burn and contribute to energy-production, and this has to be taken into account in arriving at the total basic energy-requirement.

Basic energy-requirement depends upon the area of the body-surface of the animal. This area has a relation to weight also, though not proportional.

In all feeding problems the question of live-weights comes up. In the absence of weighing arrangements, dependence has to be placed on calculation based on size and also on Tables showing weights against such size. Such methods of calculation without Tables are given in Para 925.

648. Maintenance S. E. of cow and live-weight of cattle: It is generally computed that a cow weighing 1,000 lbs. requires 6·0 lbs. of starch equivalent of energy for maintenance, including '6 lb. of digestible, crude portein. Upon this the requirements for a cow of say 500 lbs. cannot be proportionately calculated as requiring 3 lbs. of S. E. The 500 lbs. cow will require a little more. It is easy to understand

that two 500 lbs. cows will require more feed than one 1,000 lbs. cow. It is practically so, and is scientifically also found to be so. The energy-requirement varies as the two-third power of the weight or, according to another authority, it varies as $\cdot 73$ power of the weight. It is difficult to find out $\cdot 73$ powers. It is not necessary to do so, however, for ordinary purposes. The following Table will serve as a guide for finding the differences in S. E. requirement, according to varying weights. The Table is taken from I. C. A. R. Bulletin No. 25. by Dr. Sen. It is based on Morrison's data for American cows. The *Live-weight* of cattle can be determined from the Table or by calculation or by actual weighing. Method of calculating the weights from chest girth, are given in Para 925. (671, 726, 767-'68, 925, 971-'72)

649. Nutrients required for maintenance of dairy cows per head per day.

TABLE—40

Live-weight Pounds	Digestible Protein. lbs.	Digestible carbo hydrates, Starch equivalent. lbs.
500	0·338	3·05
600	0·399	3·58
700	0·458	4·09
800	0·516	4·59
900	0·570	5·08
1,000	0·625	5·57

From the above figures it will be seen that if the values were proportionately worked out and a little addition made for diminishing weights, it would not be very far off the mark. (673)

650. Starch equivalent of protein : Starch equivalent of crude protein is taken as '94. There is a difference between crude protein and pure protein. Crude protein, as is found in fodder, consists of a mixture of pure proteins and bodies known as amides. For fodder-estimation they are taken together. One pound of pure protein is equivalent to 1.25 lbs. of starch, so that its S. E. is 1.25. But a pound of amides is equivalent to .6 lb. of starch. It is, therefore, that one pound of mixed material, designated "crude protein", is taken as equivalent to .94 lb. of starch. (657)

651. Starch equivalent of carbohydrates : In measuring the starch equivalent in feeds the quantity of digestible carbohydrates is taken into account. It has been previously mentioned that oil or fat are also converted forms of carbohydrates worked in the plant or animal body. Waxes also fall under that category. One pound of pure oil is equivalent to 2.4 lbs. of starch. But oily or waxy substances do not always and wholly occur as pure substances ; there are various grades of them, the energy values of which would be various. As a general basis of calculation, the S. E. of feeds for oil or fat is placed at 2.25. In other words, one pound of fatty substance in fodder is given 2.5 S. E. value. In analysis the term fat is not used for those substances. All the oily matter that comes out by extracting the fodder with ether is put in as ether-extract and S. E. value of 2.5 is given to it. The ether-extract is to be multiplied by 2.5 to obtain its S. E.

652. Digestibility of feed : In finding out the maintenance-requirements we have to take into account the starch-equivalents not of the whole of the carbohydrates and of the proteins of the feed, but only of the digestible portion of them. In the Table 40 the figures give the digestible proteins and carbohydrates that have to be fed in order to ensure the maintenance of cows of various weight.

All that is fed is not digested. It would not help the cow at all if she is fed a stuff which she cannot digest. That portion which is indigestible is useless to the cow and is thrown out. It is of great importance, therefore, to determine and know the digestibility of the feed as a whole and of the various items that go to form the feed. Two fodders identical in chemical composition, showing identical protein and carbohydrate values, may be widely different in their behaviour as regards digestibility. One may be very materially digestible and the other may be quite the opposite of it. Both in choosing and evaluating the feeds, their chemical composition cannot guide us, unless along with the chemical compositions their digestibilities are considered.

The digestibility of every important fodder has to be known along with their compositions in order that one may judge their suitability as particular feed. In other countries the digestibilities and the compositions are all worked out by scientists for the benefit of the dairymen and breeders of live-stock in general. In India this work has only recently been undertaken,

and a few common feeding materials have been analysed for their digestibility. (819, 822-'24, 833-'34, 890, 905)

653. Chemical composition and digestibility :

The chemical composition of fodders and concentrates can be easily found out in any ordinary chemical laboratory. But special handling arrangements are necessary for animals in order to obtain digestibility records. For this purpose the animal is kept in a stall during the experiment in which there are arrangements for collecting the entire urine and faeces of the animal without any loss. A weighed quantity of feed is placed before the animal, and what is left over of each item is taken back and weighed, the difference showing the quantity fed. From the composition of these feed-materials, calculations are made of the total carbohydrates, proteins and minerals ingested by the animal. On the other hand, all the excreta are collected and weighed; the carbohydrates, proteins and minerals that have come out are found out; the portions that have been digested are determined by the difference. Thus the digestible proteins and digestible carbohydrates and also digestible minerals are found in the feed.

654. Difficulties in individual feed determination :

There is difficulty in arriving at digestibility results. The digestibility of individual feeds are easily determinable when such feeds contain more or less all the ingredients required by the cow. If the feed is lacking seriously in one or other vital components, the cow will either not take the feed or the feed will

be found to be extremely indigestible as a single feed. When the substances that were lacking are given with the feed and the combined fodder is fed, then only can the animal be kept on the diet sufficiently long, to give reliable results. These are the difficulties in determining the digestibility of feeding materials. A beginning has been made, and in course of these few years the results that have been obtained are remarkable for their importance.

655. Behaviour of rice straw : Many well-known feeds are exhibiting peculiarities the knowledge of which will now allow their utility to be increased by using them in mixtures suitable for digestion. Rice-straw offers a striking example. Analysis shows that rice-straw contains a certain amount of protein—generally 3 to 4 per cent of crude protein. If there is a cow of 500 lbs. live-weight to feed, her maintenance-requirement will be from the Table 40, 0·338 lb. of protein. There are 3 to 4 lbs. of crude protein in 100 lbs. of rice-straw. As the maintenance requirement of protein is found to be ·338, therefore, 10 lbs. of straw will give ·3 to ·4 lb. of protein which may be just enough for mere maintenance. For milk or pregnancy or for growth, something more will be necessary. But now, if we look at the Digestibility Chart, we find that the protein of rice-straw is wholly indigestible ; its digestibility value is nil. Under the circumstances, if the poor cow is given rice-straw and that as the only feed, the result will be that she will be starving in protein every day such feed is given. We shall later on see what effect such a feed

may have on her system. For our present purpose, this 'Zero' digestibility of the crude proteins of rice straw should warn us and make us give due importance to the digestibility figures and make us careful so that every time we consider a feed we take care to know its digestibility. (397, 505, 794-814, 826)

656. Recording of digestibility trials : When a digestibility-trial of a fodder is made, the results are put in such a form that ready calculation can be made from them for determining its real feed value. The feeding of that fodder may be regulated accordingly, and if any combinations are necessary, such combinations might be formulated from the digestibility of other available feed-materials. Usually the results of digestibility trials and chemical analysis results are recorded about the following item : (1) Crude protein, (2) Carbohydrates, (3) Fibre, (4) Nitrogen-free extract, (5) Ether-extract, (6) Nutritive ratio. These and percentages of the different mineral constituents of the feed complete the Table. We shall now try to understand the significance of the foregoing items.

657. Crude protein value : (1) *Crude protein*,— This term is used for the mixture of protein and allied substances in the feed. In energy-determinations, proteins are valued differently according to grade. The pure proteins have 1.25 S. E. value. The amides have only .6 S. E. value. The relative proportion of these are indefinite. Authorities differ as to the nutritional protein-value of the amides, which are also nitrogen-containing substances. Some regard these as having only half the value of true proteins.

We shall know more about proteins later on. For our immediate purpose, we shall take crude protein to mean a mixture of true proteins and amides having various protein values, the energy of the mixture being put at '94 S. E. (607, 650)

658. Carbohydrates value : (2) *Carbohydrates* include a lot of substances. They form the woody frame-work and are also the chief reserve food stored in seeds, roots and tubers. The carbohydrates comprise about three-fourths of all the dry matters in the plants.

Carbohydrates are composed of carbon, hydrogen and oxygen. It is a peculiarity of the carbohydrates that their hydrogen and oxygen contents are in the ratio in which they exist in water, namely as 2 : 1. Water is chemically H_2O or two atoms of hydrogen united to one atom of oxygen. In the carbohydrates, hydrogen and oxygen are found in this 2 : 1 proportion. Here lies the difference between the carbohydrates and oil fats and waxes. The fats like carbohydrates are made up of carbon, hydrogen and oxygen. The proportion of oxygen is much less and of the carbon and hydrogen much greater in fats than in the carbohydrates. (623)

659. Sugar and poly-saccharides : The carbohydrates consist of two groups—the sugars and the poly-saccharides. Sugars are simple substances and are easily digestible. The other group is complex. These complex carbohydrates form the wood fibre of plants. They are digested with difficulty. A large amount of energy is lost in their digestion, varying

according to their composition. They have a low feeding-value. The harder woody portions are not digestible at all. It has been previously mentioned that sun light and chlorophyll play their part in the formation of carbohydrates. These form the carbohydrates in stages. The green-coloured portions of plants, the leaves and barks, under the influence of sun light convert the energy-poor carbon-dioxide into energy-rich carbohydrates. The primary products are regarded as simple compounds like sugars, belonging to the first group of carbohydrates. How chlorophyll or the green colouring-matter of plants builds the simple organic compounds is not known. It is a mystery of the life-process. Eventually the energy of the sun gets fixed up in the organic compound, thereby the carbon of the carbon-dioxide of the air, an incombustible substance, becomes converted into the combustible and heat-giving substances like sugar or starch. From these sugars the plants proceed to make more and more complex hydro-carbons, ending in the *poly-saccharides* of the hard woody structure. Hydro-carbons, therefore, present a range beginning from soluble substance like sugar and passing through the water-insoluble but acid-soluble form of starches, and thence to the stage of oil and also to indigestible hard wood fibres.

The word poly-saccharide on examination will be found to reveal its meaning. It is a combination of many saccharides or sugars. Many sugar molecules combine to form a molecule of poly-saccharide. They contain primarily $H_{10} O_5 C_6$ or 10 hydrogen 5 oxygen

and 6 carbon atoms as a saccharide, and then any multiples of these go to form the more and more complex products, ending in wood.

This process of building up from saccharides to poly-saccharides may be reversed, and the poly-saccharides broken down through the influence of enzymes or through the action of heat and acids. In the animal body this change of breaking-down to simple soluble forms takes place.

Starch is one form of carbohydrate. It is found in cereals and in roots or tubers. These are used as human food. Starch is more complex than sugar.

660. Fibre-value : (3) *Fibre value*,—Celluloses are forms of carbohydrates found in forming the cell-walls of plants. Cellulose is more complex than starch. By heating cellulose with acid it can be broken down into sugar but not so readily as starch can be broken into sugar. The cellulose gradually merges into more and more resistant forms. Simple boiling with acid cannot then dissolve them. This insoluble form is designated *crude fibre* or *simply fibre*. In the analysis of plants the word fibre is used.

FIBRE ESTIMATION : Plant substances after drying and powdering are acted upon by acid for a long time. All the soluble portions are brought out thereby. What is left after washing out is known as fibre. Fibre, therefore, is the form of carbohydrate which is insoluble in acids. What the acids cannot perform, the stomach may. And some portion of fibre is

digested in the animal system which is then utilised just like the other soluble forms of carbohydrates. There is a great loss of energy in the process of chewing these crude fibres and in their digestion ; their nutritive-value, therefore, is very low.

661. Nitrogen-free extract : (4) *Nitrogen-free extracts* are also called soluble carbohydrates. These include the more soluble forms, such as sugars, starches and half-formed cellulose—a substance midway between soluble form and fibre. Some other soluble substances which are found in plants in small quantities, such as the organic acids, are also included in the nitrogen-free extract. This substance is not actually sought for in analysis but is found from difference. The percentage of water, ash, protein, fibre and fat found in 100 parts of the substance are added up, and what remains to make up to the total of 100 is put down as soluble nutrients. The cereals show particularly high figures for nitrogen-free extract. It is because they contain a large amount of starch which is a soluble substance in acids. The hays and roughages are low in nitrogen-free extract. Even then the soluble portions of hays contain the semi-formed cellulose etc. The nitrogen-free extract, therefore, of these substances is less nutritious than the nitrogen-free extracts of seeds or oil-cakes.

662. Ether-extract value : (5) *Ether-extract*,—All the substances in a plant-body that are soluble in ether are termed fat. The extracts, therefore, not only contain fat but the various other fat-like substances also. The ether-extracts of seeds would

be nearly entirely fats, while the extracts of roughages will consist of waxes and chlorophyll. They would, therefore, show different energy-equivalents. This is allowed for in analysis by putting 2.25 as the Starch Equivalent of ether-extract as an average figure. The fats show the following gradation :

Fat in coarse fodder	1.9	Starch Equivalent
Fat in cereals	2.1	„
Fat in oil seeds	2.4	„

The accepted average Starch Equivalent is 2.25 of a mixture of these items.

663. The nutritive ratio : (6) *Nutritive ratio*,—The contribution to nutrition is largely and essentially that of proteins. Carbohydrates and fats supply energy and not nutrition in the sense of building or repairing of the body. Minerals and vitamins are accessories and necessary materials ; but their quantity is small compared with that of protein. From these and from other stand-points the nutritional value of protein is given prominence, and in any fodder or concentrate this protein factor is generally the determinative of valuation. In feeds, carbohydrates and ether-extracts are cheaper materials. Any grass or hay will give these in good quantities. Not so is the case of protein. It is the costliest portion of fodder. Specially for growing animals and dairy cows. As a practical measure it is reasonable that stress should be put on this ingredient.

The determinative nutritive ratio is a flexible figure, depending upon the nature of the animal and

the nature of the work expected. It is generally classified as narrow, medium and wide.

Narrow ratio is	...	...	1 : 4	
Medium „ „	...	...	1 : 5	
Wide „ „	...	...	1 : 8 and upwards.	

A buyer of fodder or concentrate may reasonably ask himself—what amount of digestible protein am I going to get out of this stuff? In order to clearly define this, the finding of the nutritive ratio has been introduced. It means the ratio of digestible protein to other digestible nutrients in the fodder. If the nutritive ratio of a fodder is put at 1:10, it means there is one part of digestible protein to 10 parts of digestible substances in the fodder.

664. Digestibility of barley and gram : In the case of Barley and Gram the following figures are given about their digestibility analysis :

TABLE—41

Digestible nutrients per 100 lbs. of dry materials.							
Name.	Place of origin.	Crude protein	Carbo-hydrate	Ether extract	Total	Nutri-tive ratio	Starch equivalent.
		1	2	3	4	5	6
Barley—Bangalore		7·39	75·69	1·30	86·01	10·6	84·6
Gram—Bangalore		14·38	68·27	1·96	82·01	4·7	78·5

The nutritive ratio of Barley is given as 10'6 (Col. 5), meaning that there is one pound of digestible protein to every 10'6 pounds of other digestible nutrients in it.

And what is the total of digestible nutrients in Barley ? The answer is in Column No 4. Total, which

gives 86.01, meaning for every 100 pounds of dry Barley, there are 86.01 pounds of total digestible nutrients.

How is this total of 86.01 arrived at? It is arrived at by adding the digestibility percentages of Protein (Col. 1), Carbohydrates (Col. 2), and of Ether-extract (Col. 3). But before adding up Cols. 1, 2, 3, the Ether-extract is to be multiplied by 2.25 to bring the fats down to the level of carbohydrates. We can then add carbohydrates and fats together. Therefore, Ether-extract Col. 3, 1.30 is multiplied by 2.25, giving 2.93 as the product. The items now stand as:

Digestible Protein	per 100 of substances	...	7·39
„ Carbohydrate	„ „	...	75·69
„ Ether-extract	× 2·25 „	...	2·93
			<hr/>
Total—			86·01
(as in Col. 4.)			

The total digestible nutrient is now found to be 86.01. Out of this, proteins constitute 7.39. If protein is taken out by subtraction.

Total nutrients	...	...	86.01
Protein	...	...	7.39
Nutrients other than protein—			78.62

Therefore, for every 7.39 of digestible protein there is 78.62 of other digestible nutrients. Dividing 78.62 by 7.39, the quotient 10.6 gives the nutritive ratio.

Similarly the figures from Gram may be worked out and interpreted.

665. Composition of fodder : Without going into the digestibility trials, analysis can be made in the laboratory, where also interesting results are obtained. These are interpreted below.

Chemical composition of Barley is given as under :

Barley (Bangalore) 100 parts dry substance contains—

(a) Mineral constituents : ash—	...	4.53	(1)
(b) Organic constituents :			
Crude protein—	...	9.48	(2)
Fibre—	...	5.23	(3)
Nitrogen-free extract—	...	79.09	(4)
Ether-extract—	...	1.67	(5)

Total— 100.00

Barley contains mineral 4.53 per cent, crude protein 9.48 per cent, Nitrogen-free extract, ~~79.09 per cent~~ and Ether-extract 1.67 per cent. There is no moisture in it. Before analysis, the moisture is dried out. Commercial barley will have 10 to 12 per cent moisture and the results on each item will be correspondingly lower. Ash, crude protein, fibre and ether-extracts are found out separately, and by subtracting their total from 100 by difference, Nitrogen-free extract is found and put at 79.09.

This portion of the report, however, has not revealed everything to us. We have yet to learn about the different items that go to constitute the

percentage of ash. This is supplied in the next analysis Table.

A fresh example is taken.

666. Ash percentages :

TABLE-42

Total ash.		Gram grain only.	Gram with pods.	Rice-Bran. Bengal.
Total ash	...	3.50	9.08	15.85
Acid soluble ash		3.42	8.38	11.29
Calcium	CaO	0.33	1.94	0.22
Phosphorus	P ₂ O ₅	0.93	0.56	6.23
Magnesium	MgO	0.27	0.50	0.26
Sodium	Na ₂ O	0.22	0.16	0.38
Potassium	K ₂ O	0.72	2.15	0.19
Total soluble		2.47	5.31	7.28

An examination of the above Table reveals that in all the three substances out of the total ash a good portion is soluble in acid. Only the acid-soluble portion can possibly be digested and enter into the final metabolised products of digestion. Of this soluble ash, the most important ones are only tabled, namely Calcium, Phosphorus, Magnesium, Sodium and Potassium. These oxides are shown and the symbols of the oxides of these mineral substances are given. CaO stands for Calcium oxide. P₂O₅ for Phosphorus pentoxide. MgO for Magnesium oxide. Na₂O for Sodium oxide. Na is abbreviation of Natrium meaning sodium. K₂O for Potassium oxide. K standing for Kalium meaning Potassium. The sum-total of these

oxides do not equal the total soluble ash. They cannot for two reasons. One is that all the items are not included in this Table, and the other is that the ash is not necessarily in the form of oxides. For a convenient comparative measure they are calculated on the basis of the oxides.

667. Ash of rice-bran : We shall now examine the items more carefully and comparatively. It will be seen that rice-bran shows the highest ash. It contains only 22 per cent of calcium (oxide) but 6.23 per cent of phosphorus. Phosphorus is a very coveted substance in nutrition, so also is calcium. Of the three substances selected at random rice-bran shows the lowest share of calcium and an inordinately high share of phosphorus. Those who have been seeking for a source of phosphorus in the feed will be glad at finding such a phosphorus-rich material. But the joy will be short-lived after digestive trials are made. Such trials will show that the high content of phosphorus is a drag, for the cow cannot absorb it in her system i. e. digest it. Although gram shows less phosphorus than rice-bran yet experiment may show that the little amount is more valuable than the preponderatingly high phosphorus-content in the rice-bran.

668. Return the bran phosphorus to soil : Such an examination should also show how necessary it is to return the rice-bran to the soil after use. The soil of India is in most parts said to be deficient in phosphorus. One cannot, therefore, afford to waste phosphorus contained in the rice-bran by

allowing it to be used for filling pits or keeping it in such a way that it may not usefully return to the soil. It has to be returned to the soil, and this will be a step taken for conserving the fertility of the soil.

When paddy is sent out of villages and gets accumulated in rice mills, the reverse of this happens ; soil fertility is exported with the paddy in the form of bran. When rice is milled, the bran is treated as a waste-product, and the accumulation cannot even be economically used round about the locality where the paddy is milled. Thus phosphorus, one of the life-giving ingredients of the soil, is robbed from village fields and allowed to be dissipated about the rice mills.

Under the old conditions when paddy was husked in villages, the robbing could not take place. The villagers husked the paddy, and the bran remained to feed the village animals and ultimately got returned to the soil through cattle-manure. Even if cattle-manure was burnt, the ashes comprising the coveted minerals went back to the soil. How conscious are other countries about *conservation of the fertility of the soil* ! Education there teaches people to love the soil and do their duty by it. But what India has received in the name of *education* has no relation to things of the soil. Education has lifted people up from the soil to a visionary region. In American literature on live-stock production, on dairy farming etc., one constantly comes across passages of striking appeal about the conservation of soil-fertility.

669. Conservation of soil-fertility : There are poster illustrations recommending farmers to retain the fertility of their soil. Hay or straw selling is also discouraged, showing that the better way is of rearing cattle and receiving better return by the sale of milk-products and at the same time conserving the fertility of the soil.

Before the introduction of modern machine days in India, all these points like conservation of soil-fertility were naturally safeguarded. Things have fast changed for the worse, and cattle-mindedness, a sure precursor of prosperity, has gone from our land and has taken root in modern America, Britain, Denmark, Germany and Russia etc.

670. Mere chemical analysis fails to guide : We have come a long way with soil phosphorus. Reverting to the other aspects of the analysis of fodder, it has to be observed that mere chemical analysis of its components without digestibility-trials going side by side may be very misleading. Even then the inherent deficiencies are made apparent if an windfall like the phosphorus of the rice-bran proves to be unsubstantial in the end. There are the two items in the fore-going Table of gram grains only and gram with pod. On examination it will be found that pods have lowered the phosphorus-content, indicating that the pods are too poor in this mineral. These points of analysis, both chemical and through digestibility trials, require to be well studied with regard to the fodders of a locality.

671. Basis of maintenance : So far only the maintenance ration basis of proteins and carbohydrates has been considered in the Table No. 40. (649). It has to be remembered that the maintenance requirement Table is only to be regarded as a base upon which the feeding structure has to be built. Mere maintenance without movement is a scientific laboratory consideration. We have to consider in practice the nutritional requirements of cows in milk, of dry cows, of heifers or growing cows of cows carrying calf, of bullocks at rest and at various grades of work. They have to be fed at all these stages to obtain the utmost efficiency. A few Tables and data are necessary for constructing such ration programmes, primarily on protein and energy-requirement, based on the assumption that a cow weighing a thousand pounds requires 6 lbs. of S. E. including 0.6 lb. of digestible crude protein. (648)

672. Requirements for growth : Calves of Haryana and Montgomery breeds put in 8 lbs. of weight per week. In some specially-managed farms the daily weight increase for the first few weeks of calf-life may go up to $1\frac{1}{2}$ lbs. We shall know more about this when we discuss the subject of the rearing of calves. Calves above 100 lbs. may be gaining on the average 1 lb. per day increase in weight till the attainment of full maturity. Upon this assumption the energy-requirement will be from 2 to 3 lbs. of S. E. per day, in addition to their maintenance requirement. (689, 769, 770)

673. Nutrients required for growing dairy cattle :
Based on Morrison's data (Sen).

TABLE—43

Note : In the original Morrison Table the values are given as maximum and minimum requirement. In this Table a mean has been struck. In the original Table energy is given in therms. It is calculated to S. E. here by dividing the therms by 1·07.

Live-weight. lbs.	Digestible protein. lbs.	Starch Equivalent. lbs.
100	0·32	1·8
150	0·47	2·4
200	0·57	3·3
250	0·66	3·9
300	0·73	4·5
400	0·85	5·3
500	0·93	6·1
600	1·00	6·8
700	1·07	7·4
800	1·13	8·0
900	1·19	8·7
1,000	1·25	9·2

It will be seen that in a herd a cow weighing normally 500 lbs. at full growth, the feeding should be at the rate of nearly 1 lb. (.93 lb.) of crude protein and 6·1 lbs. of starch equivalent.

Suppose we want to keep a growing cow weighing 500 lbs. solely on *Dub* grass. We may try and see what we have got to do to achieve this. (649)

674. Nutrition value of Dub grass : Looking at the Tables below we find that the *Dub* grass hay of different places have different nutritive values. The Bangalore hay contains as much as 7.28 per cent of digestible protein and has 34.8 per cent starch equivalent ; Karnal hay has 3.31 per cent crude protein and 25.9 per cent starch equivalent. Five varieties are tabled as under :

TABLE—44

Place.	Crude protein. per cent.		S. E.
Bangalore	7.28	...	34.8
Bareilly	4.45	...	26.5
Fyzabad	3.76	...	26.6
Lucknow	3.68	...	30.6
Karnal	3.31	...	25.9
Lyallpore	5.44	...	28.7

The values are on a 10 per cent moisture basis of hay and not on the laboratory basis of 100 per cent dry. For 100% dry material the values would be about one-ninth more. But commercially we get 10% moisture normally in hays. From the above 6 reports, we may take an average quality mid-way between the very rich Bangalore hay and the very poor Karnal hay, and select for our present consideration Fyzabad hay as being of the medium class, more likely to be met with at many places.

Fyzabad hay having 3.76 per cent digestible crude protein will require 25 lbs. to be fed to yield the required .93 lbs. On S. E. value of 26.6 for this hay

our requirement for the 500 lbs. cow of 6·1 lbs. will be met from 23 lbs. Whichever point we may emphasise, we see that we require from 23 lbs. to 25 lbs. of dry hay to be fed per day to feed a 500 lbs. growing cow, or say a heifer. The question then comes—can we feed her this quantity? So much of hay cannot be fed to a 500 lbs. cow.

675. Ration for growing dairy cattle: In Morrison's Table referred to already, there is a column for dry matter which can be fed to the growing cows.

TABLE—45

Weight. Pounds.	Dry matter. Pounds.	Nutritive Ratio. 1:
100	1·4 to 2·4	3·9 to 4·5
150	3·0— 4·0	4·4— 5·1
200	4·6— 5·6	5·0— 5·5
250	5·9— 6·9	5·7— 6·2
300	7·2— 8·0	6·3— 6·8
400	9·0—10·0	6·5— 7·0
500	10·6—11·8	6·9— 7·4
600	12·0—13·6	7·2— 7·7
700	13·4—15·5	7·4— 7·9
800	14·8—17·4	7·6— 8·1
900	16·1—19·2	7·8— 8·3
1,000	17·5—21·0	8·0— 8·4

It will be seen that for a growing cow of 500 lbs. weight the total weight of dry matter should be between 10·6 and 11·8 lbs. But, if we are to feed hay we shall need feeding her 23 to 25 lbs. which is an absurd proposition. (On general consideration this

is supported, for it is an accepted limit that the quantity of dry matter fed should be about 2 per cent of the body-weight. The Chart above works out within this limit. We find, therefore, that a growing cow requiring 1 lb. weight increase per day cannot be made to depend upon *Dub* grass alone as a single feed. On it alone she may get only half of her required feed. That means that there will be not only no growth, but emaciation will set in. From another consideration we come to the same conclusion, that the *Dub* grass hay is too poor a material on which to keep a growing cow solely.

In the Table above, the last column shows the nutritive ratio of the feed necessary. For a 500 lbs. growing cow the feed should have, according to the Table, a nutritive ratio of 6·9—7·4. Whereas the nutritive ratio of the Fyzabad hay of our selection has a ratio of 9·4. This indicates that Fyzabad hay is not so rich in its proportion of protein to other nutrients that it can alone support the growth of 1 lb. per day.

We, therefore, shall have to fall back upon some other hay if available in the locality, which may be better than the *Dub* grass. There are many leguminous fodders rich in nitrogen. We may select one of them with a close nutritive ratio, or failing this, we shall have to take recourse to the most usual way of adding some concentrates to the feed. We may try a leguminous hay now.

Berseem hay of Lyallpore has a nutritive ratio of 5·4 closer than our requirement. Its digestible

proteins and starch equivalents on a 10% moisture basis are 9.26 and 42.6. This works out as under :

For .93 lb. of the protein-requirement of our 500 lbs. cow, we shall need approximately 10 lbs. of hay. The energy-needs of our growing cow of 500 lbs. is 6.1 lbs. This can be obtained by feeding about 14 lbs. of Berseem hay. It is found, therefore, that though Berseem hay will supply the protein requirement fully if fed at the rate of 10 lbs. per day, it will fall short of the energy-requirement. The starch equivalent of Berseem is not high enough to suit our case. So Berseem fails. (680, 871, 874-'78)

676. How to grade up the starch equivalent : We may look for some hay having still closer nutrition ratio. Cow-pea hay and ground-nut hay have much closer nutritive ratio, being 3.9 and 2.3 respectively ; but the starch equivalents of these are lower even than those of Berseem hay and, therefore, cannot meet our case. For a 500 lbs. growing cow the requirement set forth has been rigid on the Morrison scale. In this scale the quantity of dry matter is limited to 10-11 lbs., and on the other side the S. E. has been set at 6 lbs. If 6 lbs. S. E. is to be obtained from 10 lbs. of dry feed, then the S. E. of 100 lbs. of feeding stuff should be 60.

The way to grade up the S. E. is to include the requisite quantity of one of the concentrates, the S. E. value of which runs up to even 80 per 100 lbs., in the case of cereals. A mixture of cereals for S. E., of legumes for protein with some cake for minerals and

hay as roughage will be the direction to which we shall have to look. (646)

677. Familiarity with the use of Tables : In this exercise we have made attempts to be familiar with the use of Tables. It has not been a real search for a proper feed for our cow, for we have not gone into the mineral requirements at all, in this instance. And without the proper dose of minerals the feed will be no good. Here again, no mere percentage statement of mineral contents can satisfy. If the percentage gives the requisite quantity, still the matter of their digestibility or absorption will have to be gone into. Before proceeding so far it would be better to know the entire range of requirements first. So far, only the subject has been opened. We have yet to know more about proteins, minerals and vitamins before the construction of a ration may be attempted.

678. Optimum plant growth for fodder : When we took up the case of Berseem for testing its suitability as a single feed, we did not consider in what stage of growth of the legume was it harvested and made into hay, and how it was made into hay. But the matter deserves enquiry from the point of view of the valuation of its digestible nutrients. In fodders there is a stage of optimum growth for supplying nutrition to the herbivora. Very early in life the fodder plants are too watery and too succulent to give sufficient starch equivalent values. Their fodder-value increases with their growth and reaches the maximum at the time when the seeds are forming past the milky stage. After that stage soluble nutrients

in plants diminish as the woody portion increases, while the seeds get richer in value. For use as a fodder, harvesting is to be done before the seeds are hard. When legumes or cereals are grown for human consumption then the best portion of the plant structure is taken away by man. The stalks, robbed of their rich nutritional value, are given to animals. When the cereals and legumes are grown for fodder, the greater food-value for animal-feeding is obtained, if harvested before full maturity. The fodder harvested at the proper time will give more nutrition than if they were allowed to seed and ripen, and both seeds and stalks were used for cattle-feeding.

At the optimum stage for fodder harvesting the plant had taken all that it could have taken out of the soil and the air. During the ripening days, the materials reserved in the stalks, leaves, and roots, are marshalled out for the formation and ripening of seeds. The plant knowing that life is ending strives its utmost to send out as much as it can by conversion of its body-material into seed making, so that the more the number of seeds and the more they are developed the more the chance it will have of living on the soil through the seeds. By procreation, the plant remains eternal and its hunger for life makes it bloom forth into flowering and subsequently into seeding.

It will be apparent, therefore, that the time of harvesting is a great factor, affecting the usefulness of fodder as a nutrient. The more mature it becomes the more woody the cellulose or carbohydrates

become. Some turn insoluble, and those that remain soluble lose their energy-value on account of having changed their character from the simple to the complex.

679. Stages of plant maturity : In fodders like *joar* or maize, when the plants are young, there is very little of any nutrient. The succulent leaves contain much water. Protein, fibre and nitrogen-free extract are all insignificant. With the growth of the

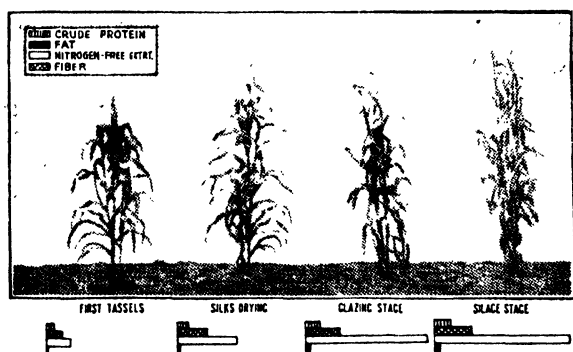


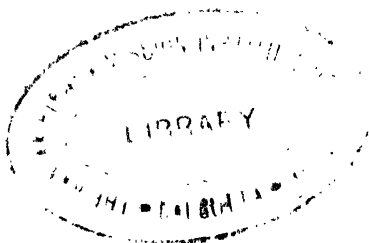
Fig. 42. Stages of plant maturity.

plant, the nitrogen-free extract goes on increasing, and the proteins and the fibres cannot keep pace with it. Gradually fat also appears and the nitrogen-free extract reaches its highest before the corn is mature. The stage at which a fodder is harvested is a matter, therefore, of great importance.

680. Grasses more nutritious at early stage : What happens in grasses is somewhat different from that in cereals and legumes. In grasses, however, the

earliest leaves are more full of protein and minerals. As time proceeds, the percentage of proteins and minerals go on decreasing and the stalk goes on becoming more woody. This matter is dealt with more fully in connection with grass. It has to be observed here that green fodder has more digestible nutrients than dry fodder. In the course of drying, the solubility of the carbohydrates goes down. The quality of carbohydrates depends not only upon drying but also on the manner of drying. Storage also deteriorates the nutritional value of carbohydrates.

Carbohydrates appear in several other forms in plants. The pectins and gums and gummy substances are also carbohydrates, giving food-value. (675)



CHAPTER XIX

NUTRITIONAL REQUIREMENTS.

681. **Calculating feeds from Tables:** In Chapter XVIII, Para 673, an attempt has been made to find out a balanced ration for a growing dairy-cow of 500 lbs., which requires .93 pound of digestible protein and 6.1 lbs. of starch equivalent from a single item of feed. It was found that Berseem hay could supply the necessary amount of protein from the 10 to 11 lbs. of feed which a 500 lbs. cow could ingest, but, that this quantity would not be able to give the required energy and, therefore, Berseem was found wanting. But the Tables, however, do not say everything about fodder and feeding, and a blind dependence on them may lead us nowhere.

It is not that a 500 lbs. cow cannot take more than 10.6 to 11.8 pounds of dry fodder. It is a suggestion to serve as a guide in average cases. Cows can take $2\frac{1}{2}$ per cent of their weight of dry fodder if the fodder is palatable and provides a square ration, satisfying the mineral and vitamin requirements as well. The feed of dry fodder then may be increased so as to make it $2\frac{1}{2}$ per cent of the live-weight. This comes to $12\frac{1}{2}$ lbs. We had been working on Berseem on a 10 % moisture basis. But the $2\frac{1}{2}$ per cent live-weight basis is of 100% dry fodder. On that basis $12\frac{1}{2}$ lbs. would correspond to 13.7 lbs. against the requirement of 14 lbs., as

calculated for her. As the tabulated figures are approximations, 13·7 lbs. feed in place of the 14 lbs. required is practically meeting the requirement. It would, therefore, seem that Berseem need not be rejected as a single feed for a growing 500 lbs. cow. As a matter of fact, it has been practically found that Berseem can be used as the sole fodder in such cases.

But we have not covered all the grounds. Berseem hay has been selected. There is no reason why the stuff should be fed as hay all the year round and not partly as green fodder. If this is not done, if a dry fodder is fed continually, then, in spite of the richness of Berseem, the cow will lack in nutrition ; for hay will hardly have the full quantity of Vitamin A that the cow will need. And without Vitamin A she will break down and refuse to eat all that quantity of fodder presented to her.

682. Selection of feed : From this illustration, it will be apparent that in the matter of selection of feeds, the Tables cannot be our only guide. These show the line of working, but a knowledge of the behaviour of the selected feeds and their reaction upon the system of the animal should have to be considered. Before attempting to calculate the ration on the basis of the Tables, it is necessary to know all about the feed-requirements and about the general character of the particular feeds available. It is more than the simple mathematics of finding out the figures from the Tables and calculating down if the feed falls within the range. Intimate acquaintance with the feeds is a matter of first importance. Upon

that ground and also upon the basis of a store of practical experience of the breeder, can the Tables be of value in the selection of feeds.

683. Carbohydrate as nutrient: We have known something about the carbohydrates in plant and animal economy. It is also of such great importance in feeding that it will be worth while to pause and know more about its place as a feed.

Plants manufacture carbohydrate out of the carbon of the carbon-dioxide of the air. The first products are regarded as simple sugar-like substances. These simple substances get gradually changed according to the requirement of the plant and the simple carbohydrates act as building materials changing into complex substances to fulfil the various needs of plant-life. They get deposited in leaves and barks, or rather they form these and then go to form the harder and yet harder cores. The twig is a soft, yielding thing. In time the twig develops into heart-wood and gets its interior converted into a woody core. Here will be found carbohydrates in various stages of complexity of formation. Again, the carbohydrate gets deposited in tubers and in fruits and seeds as starch. In sweet fruit the carbohydrates appear as sugar while the hard fibrous hull of the seeds is also shaped out of carbohydrate combined with minerals. (630)

684. Bacterial action on carbohydrates: When a cow is fed with leaves, stalks, roots, tubers, seeds and oil cakes, the largest bulk of the stuff is formed of carbohydrates in various shades of composition, with

various physical and chemical properties. Some are soluble in water, some in acid, some dissolve on prolonged action by acids, and some refuse to be broken up at all till they are acted on by the bacteria in the animal stomach, while some pass unchanged.

The more complex and harder materials undergo this bacterial action of conversion in the stomach. Some carbohydrates begin to be changed by the ptyalin secretion even in the mouth. Fortunately cows have little secretion of this nature in their mouths as men have. If they had, a lot of carbohydrates would have got changed into sugar-like bodies, and while going past the first stomach would have been acted upon in the earlier stages by bacteria, and would have been broken up too early to be of use for combustion in the blood-stream. The energy-values of these would have then been frittered away in body-heat and not in the production of work. The fodder gets broken up partly in the first stomach to be acted upon in the subsequent stomachs.

The enzymes produced by the digestive tract are unable to digest cellulose and other complex carbohydrates. These are acted upon by bacteria in the first three of the ruminant stomachs. The bacteria break them down to organic acids and possibly into simple sugars and glucose. Gases are formed and heat is produced by the bacterial action of conversion. The organic acids go to serve much the same purpose as the sugars. The heat produced is wasted except what is required for keeping up body-temperature. But anything in excess of this need is entire waste.

685. Breaking up of carbohydrates in the rumen :

The bacteria not only break down cellulose in the rumen or first stomach but they may attack sugars and starch also: If these latter bodies are broken up here, it will be harmful, for these are more effectually digested in the small intestines ; whereas, if they are acted upon by the bacteria, their feeding-value will be materially lost (693) through the production of gas and heat.

686. Bacterial action causes bloating : Bacterial action on starch is very vigorous and too much gas may be produced when fresh and easily-fermented forage is eaten. It may be so great that gases may be produced faster than they can get away, resulting in bloating or tympanites. Those who feed their herd on leguminous pasture know how dangerous this may be. A cow may die within a few minutes after the symptoms appear. A healthy cow may be found dead while grazing.

Bacteria in the stomachs do one great service by breaking up cellulose. They expose the cell contents and, therefore, allow their absorption or allow reaction to proceed on them.

687. Carbohydrates ranging to wood fibre :

Carbohydrates occur in varied forms and stages of solubility from sugar to starch, from hemi-cellulose to cellulose, and from cellulose to hard wood fibre. These also act as the mother substance both for fats and proteins. In fats, the carbon is found in a condensed form and the proportion of oxygen is much less. Fats are formed out of carbohydrates.

688. Carbohydrate—mother of protein and fat : The carbohydrates are regarded as mother-substances in the production of protein in the plant-structure. The nitrogen of the protein though coming out of the soil is primarily of the atmospheric air. Air, therefore, is responsible for all these three forms—wood, fat and protein. The part that the carbohydrates play in the nutrition of animals is of supreme importance, although protein is given a place of more value than the carbohydrates.

689. Carbohydrates economises protein requirement : The presence of adequate carbohydrates in the feed ensures *economy* in the *use of protein*. If there is plenty of digestible carbohydrate present in a feed the consumption of protein becomes low. A sufficiency of carbohydrates including fats has, therefore, to be assured as the basis of animal nutrition.

The requirement of digestible carbohydrates has been put at 6 lbs. for a 1,000 lbs. live-weight. This is for maintenance alone. For growth or for milk the quantity has to be largely increased for satisfactory animal husbandry management. For growth, according to the Morrison Table, (673), a 500 lbs. cow will require 7·03 lbs. total digestible nutrient, including fat and protein, as against 3 lbs. for maintenance only. For milk, containing 4·5 per cent of milk fat, the total digestible nutrients should be between ·33 to ·35 pound per pound of milk in addition to the maintenance requirement. (672)

690. Storage of carbohydrates as fats : Carbohydrates and fats, after they have made their contribution to body-building and maintenance-requirements, are not rejected by the body but are converted into fat substance, forming a necessary portion of the body, giving it roundness and smoothness. In emergencies of starvation this fat is first drawn upon for use as fuel for combustion, for the life-process to continue.

Extra carbohydrate or fat has got to perform another function besides forming the fatty deposits within the body where they lie in moderate quantities for an useful purpose. This other function of carbohydrates and fats is the production of work. In this capacity, carbohydrates behave like fuels for engines. The more work is taken out of the engine, the more fuel has to be burnt. All burnt fuel again does not go to productive account. Something is lost in the process. In the conversion of heat to work, as is done in the steam engine, it is estimated that only 25 per cent of the heat-value goes to productive use ; the rest is lost by radiation, friction and incomplete utilisation.

691. Bullock as a source of power : *The bullock as a source of power* is no less efficient than a steam-engine or an oil-engine. It has been found from numerous experiments that animals can convert to work one-third to one-fourth of the energy fed, after the maintenance needs are met. Mechanical appliances for conversion of fuel to energy such as an oil-engine also do the same. The difference in favour of the

animal is this that while the oil-engine burns 100 per cent of the oil fed to it, the bullock burns only half the fodder-fuel fed, and the other half it throws out as indigestible.

There are other differences because of the nature of the animal and that of the engines of conversion. There is a factor of fatigue in living beings, which is absent in mechanical appliances. Provided the lubrication and running arrangements are perfect, a mechanical engine can perform work day after day without fatigue. For smooth working, cleanings and stoppages become necessary, but that is due to the defect either of fuel or of the method of combustion.

692. Protein requirements : The proteins are essential to all life. (854) The protoplasm in living cells and their nucleus contain protein. In plants the proteins are mostly in the leaves and in the reproductive parts. In animals the proteins form the muscles, the internal organs, the cartilages, the connective tissues, and also in the outer coating of the skin, hair, nail, hoof and horn. It is also the chief component of nerves, of the brain-matter and of the reproductive elements. By taking away all the protein substances of the body, only the bone structure will remain. It is, therefore, that the proteins are so important. Without them body-building and repair will cease ; and without them the feeds will be abnormal feeds, and the cattle will not be able to live long on such feeds. When, after the maintenance-requirements are met and an animal is called upon to do work, even then some portion of protein must be supplied

to enable the animal to utilise the carbohydrates necessary for work. When an animal works, there is no extra burning of the muscles, tissues, or body-proteins. This has been repeatedly seen. From this, one would conclude that since for work no proteins are necessary, foods containing only pure carbohydrates would do for obtaining work. But experience shows that for carbohydrate-utilisation some amount of proteins will have to be fed, otherwise the digestibility of the carbohydrates decreases.

It has been definitely determined that the absence of proteins in proper quantity profoundly affects the assimilation of easily-digested carbohydrates.

Morrison wrote (*Feeds and Feeding*, 1940. P. 68) that by a study of the results of various digestion experiments he found that when *kafr* grain (*joar*) had been fed to ruminants in balanced and unbalanced rations the digestibilities were found to be as under :

TABLE—46

	Digested in balanced ration.		Digested in protein- deficient ration.	
Proteins ...	81	per cent	47	per cent
Fibre ...	55	„	44	„
Nitrogen-free				
extract	92	„	51	„
Fat ...	76	„	51	„

The nutrients in a balanced ration showed remarkably high digestibility, whereas in protein-low ration the digestibility was remarkably poor. Morrison said that similar data could be cited for other grains.

693. Depression of digestibility : This lowering down of digestibility due to low protein-feed is called depression of digestibility. And because of this depression of digestibility it is economical to feed more protein than is needed to meet the theoretical requirements. According to Morrison the depression of digestibility occurs when the nutritive ratio (603) is wider than 1 : 8 or 1 : 10.

The easily-digested carbohydrates referred to above which show this depression of digestibility, are the cereals containing a high percentage of starch. The reason for this is that within the ruminant stomach the bacteria that are there to attack cellulose, normally to secure their food, attack the more easily-digestible starches by preference. By this not only is the digestibility of cellulose or fibre lowered, but also that of crude protein and nitrogen-free extract, because the cell walls remaining unaffected do not expose their contents to the action of the digestive juices. But, when protein-rich feeds are added to starch or sugar feeds, this depression does not occur, because the balance between protein and non-nitrogenous nutrients is preserved. By the addition of more protein, bacteria get stimulated to act more vigorously and commence to attack the more difficult portion of the feed, viz., the fibres, etc.

694. Formation of proteins : Proteins are formed by the combination of amino acids. These amino acids form various groupings for the formation of the various forms of protein substances in the animal-body. There are over twenty of these amino acids.

Therefore, there can be an almost unlimited number of combinations, generating different varieties of protein substances, from these twenty and odd different amino acids.

The proteins, as we know, are originally manufactured by the plants out of the basis of carbohydrates by the incorporation of nitrogen from the soil. We know also that the plant gets its nitrogen through the agency of a bacteria capable of fixing nitrogen. Such bacteria, the azotobacter and allied ones, live in plant-tissues and get on from there to the roots and form nitrogen-rich nodules on the roots. We shall know more about them (844-'47) when considering the leguminous plants and their importance as fodder.

695. Amino acids: The plant proteins, however, cannot be used by the animals as such. In the animal stomach these proteins are broken up into amino acids. These amino acids in a soluble form then get into the blood-stream forming in the animal body the different combinations in the different parts according to their needs. The amino acid bodies rush and pass into the blood-stream through the minutest portions of animal-body and get those parts replenished or built as are required, choosing the particular combination for the particular protein substance of the part.

696. The essential amino acids: These amino acids are not all of equal value. There are some which can be built out of others in the animal body ; but there are others which must be present in the feeds and without which the conversion and building work

cannot go on. Therefore, of the amino acids some are marked essentials and others non-essentials. The essentials must be present in the proteins of the feed. It may also be that some of the non-essentials may be synthetised by the animal. The animals certainly can break up the essentials and make from them the non-essentials. At the present stage of knowledge the following are regarded as the essential amino acids for building proteins :

- | | |
|-------------------|-----------------|
| 1. Lysine. | 6. Leucine. |
| 2. Tryptophane. | 7. Isoleucine. |
| 3. Histidine. | 8. Threonine. |
| 4. Phenylalanine. | 9. Arginine. |
| 5. Valine. | 10. Methionine. |

Besides these ten, an eleventh—‘Cystine’—was also considered to be essential. Cystine is the chief sulphur-containing amino acid. It has now been proved that cystine may not be needed if the tenth one ‘methionine’ is present. Methionine also contains sulphur. Glycine is another amino acid, non-essential but very important. It is very necessary, and it can be synthetised in the animal body from the other essential amino acids

697. Essential amino acids must be present : In blood all the essential amino acids must be present in the requisite proportion. If a single essential one is absent, then the building work of some groups of proteins will not be possible and, therefore, it will retard the growth or fail to replace wear and tear. If the proportion of the necessary acids is below what

is needed, the feed will be useless to the extent it is wanting in the amino acid for body-building and repair. Suppose, in building body-tissues 2 per cent of a particular amino acid is necessary and the ration supplied contains only sufficient to make up one per cent, then double the entire feed will be necessary to keep up the required growth or to make up the loss.

But if the feed lacks in a non-essential amino acid while plenty of essentials are fed from which the deficiency can be built, then there will be no disturbance in the normal working. For example, milk protein lacks glycine, one of the very important but non-essential proteins. No harm will be done if the essentials present in the milk are sufficiently fed. Glycine will be made in the body itself from other sources.

The essential amino acids can again be grouped into two classes—those that are required both for maintenance and growth, and those that are needed for growth only. If these latter are absent in growing animals, the growth is suspended; but if these are absent in the feeds of grown-up animals, where maintenance is the only need, then such absence will not matter. Zein is the chief protein of corn or maize. It lacks in two essential amino acids, the first two that have been mentioned in the list (696)—Lysine and Tryptophane. There are other proteins in corn which can make up for the absence of the above two to a certain extent, but that only for maintenance and not for growth. Young animals cannot attain

full growth on a feed of corn alone to supply the amino acids.

The experiments for the requirements of amino acids were made on rats. As rats re-produce quickly the effects of feeding may be studied up-to three generations in the course of a year. What applies to rats applies generally to all mammals. But ruminants form an exception in that they have four stomachs and they have special digestive methods absent in the others. The ruminants break up food-materials in their first stomach with the help of bacteria. When food-materials with these bacteria travel on to the stomachs following, some of these bacteria come to be digested themselves along with the herbage. These bacteria may supply some of the proteins from their own bodies—some essential amino acids absent in the feed.

698. Linseed meal—a special feed: As an example, it may be stated that linseed-meal alone, as the only protein supplement, gives excellent results combined with grain and hay for the cattle. This same feed will, however, prove unsatisfactory for pigs, for which, the above feed must be supplemented with protein from some other sources. Linseed-meal as cow's feed is a superb article. For calf-feeding, when a milk substitute is sought, linseed-meal gives the best result as a concentrate. In fact, there are several concentrate-mixtures known as milk substitutes for calves containing linseed-meal or linseed-cake as the chief item.

BIOLOGICAL VALUES: It will be understood that the mere presence of certain amides in a feed is

not enough. Their importance is measured by their contents of essentials or the contribution they make to growth and maintenance, which is their biological value.

699. Quality of proteins : Milk-protein is almost perfect protein, although it lacks in a sufficient supply of cystine and methionine. But milk is so rich in lysine and tryptophane that it is able to correct the deficiency in the proteins of other feeds. It is customary to speak of protein in percentages indicating their quality. Few feeds come up to 100 per cent in value. The biological value of 75 per cent indicates that the proteins are considerably better than the average. Values below 60 per cent indicate that the protein is not of high quality. The biological value of the proteins of cereals stand between 60 and 70 as against 90 or more of milk protein. (607)

700. Proteins that have high value : Generally speaking, the cereal grains have better proteins in their germs than in their bodies or the endosperms, the starchy part. In wheat-grains the bran supplies protein of a higher value than the endosperm. Wheat-bran is, therefore, superior in protein-value to the whole grain. (908) Rice-bran has proteins of some value but this material cannot be very usefully (903) included as a superior protein-concentrate on account of its mineral deficiencies.

In the legumes, the pulses and leaves differ in protein value. Soy-bean and ground-nut proteins stand very high and give excellent results when mixed with the proteins of cereal grains to make up their deficiencies. The proteins of most other beans and

pulses are inferior to soy-bean. Their deficiencies in value are somewhat corrected by mixture with cereals. The proteins from the different sources are dealt with when considering the value of the various fodders.

It may only be mentioned here that proteins of cotton-seed and linseed and cocoanut among concentrates take very high places. (912-915) Among roughages alfalfa and clovers stand very high and can be depended upon as sources of high-grade protein.

Grass pasture also is a very superior source of proteins. The young shoots of grass, just coming out of the soil, are almost milk-like in their protein-value. Composition of the soil, fertility etc., influence the biological values of the proteins of feeds, the same feed having one value in one locality and another value in another. (848-'57)

701. Protein requirements : There have been no end of experiments with the protein-requirements of the cow. Some have arrived at very low values such as 0.21 to 0.27 lb. of digestible protein daily per 1,000 lbs. live-weight. Others regard this as exceptional. Armsby who is an authority on cattle nutritional problem regards 0.43 to 0.75 lb. of digestible protein daily per 1,000 lbs. live-weight of cow per day as the maintenance requirement. On this basis, he strikes at the average of .55 lb. and recommends .6 lb. of digestible protein per day for for the maintenance of a 1,000 lbs. live-weight.

The finding out of the absolute and true optimum requirements of various types of cattle from various feeds is a difficult and an almost impossible task. In

choosing a fodder one has to enquire how much total protein it contains, and next how much digestible protein it contains. Mere digestibility will not carry the enquirer very far, for the question of composition will come up. Does it contain the essential protein? If it is lacking in some essential amino acid then the particular item of amino acid in which it is lacking has to be determined, to find out where to look for it. Even here the enquiry does not stop. The next question that crops up is about the biological value of the combination of the proteins offered by the feed—is it to be 50 or 60 or 70? And the replies to only a few of the queries can be found from the published literature, and that again about only a few items of fodder.

Yet, this discussion about the amino acids and their biological values have not been introduced without a purpose. When the details are not known it is as well that we know the difficulties of our problem. Although definite conclusions cannot be arrived at from the published charts, yet they give indications of the requirements. The husbandman will do well to include protein in the feed from as many different sources as possible. If one is lacking the other may fill up the requirement. This, together with a knowledge of the experience and practices of discriminating husbandmen, will show a way. Pure mathematical figures are of little use. Inclusion of variety, the knowledge of the percentage of digestible proteins in feeds together with a general idea of the problem, will help to solve it, leading to better feeding management.

The practical method will be to start calculation with the maintenance-requirement of .6 lb. of digestible protein for a 1,000 lbs. live weight ; then to allow for milk or work or growth according to the needs of the animal.

702. Mineral requirements : Minerals play a very important part in the digestion and assimilation of nutrients from the feed. The minerals are in small quantities, but they exert a very profound influence. Blood contains, for example, a very insignificant quantity of iron in it. But it is through the presence of this trace of iron in the cells that the process of oxidation and rejuvenation is made possible.

It has been repeatedly observed that feeds lacking in minerals are not only *deficient*, but act as poison. Feeds from which some salts are removed will fail to maintain the health of animals. And, in case of any vital deficiency of minerals the animal will starve to death, even if the best combination of carbohydrates, proteins and fats are supplied,

In other words, animals will die much quicker if fed on mineral-free feeds than if they were starved. Feeds in such a circumstance act like poison, bringing death. As an example, it may be stated that if magnesium is wholly absent in feeds cows will develop symptom of tetany, and die speedily. The evil effects of the deficiency of the minerals in feeds is dealt with more fully in the next Chapter. The case of magnesium is mentioned by way of an illustration only. (609)

703. Mineral composition of pastures : The minerals are naturally present in the plants. And

ordinarily mixed fodders serve the purpose of feeds, sometimes efficiently and sometimes inefficiently. About pastures, the breeders know well which are conducive to development and which are not. The story of the Romney Marsh pastures, as an example, has been mentioned by Linton in his "Animal Nutrition and Veterinary Dietetics" (1927. P. 31).

"It has long been known to the practical farmer that pastures vary greatly in their feeding-value. The variations are so great that one pasture will be considered cheap at £ 3 per acre and another dear at 10 s. per acre. This range of values cannot be accounted for by any differences in the quantity of herbage or any difference in the chemical composition, as measured by protein-content and starch equivalent. Hall and Russel when investigating the 'fattening' and 'non-fattening' pastures of Romney Marsh were unable, by ordinary chemical analysis, to discover sufficient difference in the protein and starch equivalent values of the two types of pastures to account for the great differences in feeding-value obtained in practice. Recent work carried out by Godden has shown that the difference in the feeding-values of various pastures is to be found not in their content of protein and starch equivalent but in the amount of lime and phosphoric acid which they contain. ... Two sets of figures are given for each field and represent the composition of the portions eaten by stock and the portions not eaten by stock.

704. Mineral composition of Romney Marsh pastures (Godden) :

TABLE—47

	CaO %	P ₂ O ₅ %	Na ₂ O %	K ₂ O %	Cl %	N %	Fibre %	Total ash. %	Silica free ash. %
<i>Ogarswick</i>									
<i>Fattening field—</i>									
Eaten	... 1·026	1·010	0·223	4·160	1·272	3·022	19·36	12·78	8·32
Not-Eaten	... 0·738	0·564	0·349	2·247	0·820	1·594	30·06	8·69	4·55
<i>Non-Fattening field—</i>									
Eaten	... 0·888	0·735	0·127	3·180	1·092	2·840	21·52	11·71	7·07
Not-Eaten	... 0·671	0·386	0·177	1·611	0·514	1·237	31·15	7·00	3·83

705. Difference in values of pastures: "A further study of hill pastures in England, Scotland and Wales, and of cultivated pastures in England and Wales, shows very clearly that the difference in the feeding values of various types of grass land is in the main determined by their mineral composition and has little

relation to their starch equivalent. Table (below) illustrates some of the results obtained by Godden.

TABLE—48

Mineral composition of pastures : Dry matter.

	CaO %	P ₂ O ₅ %	Na ₂ O %	K ₂ O %	Cl %	N %	Silica free		Calories per 100 grams
							ash %	Fibre %	
<i>Hill pastures—</i>									
(England & Wales)									
Eaten ...	0.464	0.156	0.151	2.394	0.561	2.211	4.663	24.6	277.0
Not-Eaten	0.264	0.325	0.160	1.533	0.291	1.831	2.733	29.6	268.0
<i>Hill pastures—</i>									
(Scotland)									
Eaten ...	0.559	0.604	0.406	2.596	0.599	2.540	5.486	25.2	270.6
Not-Eaten	0.304	0.371	0.166	1.610	0.334	1.820	3.132	29.3	262.9
<i>Cultivated grass—</i>									
Eaten ...	1.186	0.854	0.236	3.450	1.079	3.238	7.630	20.6	273.0
Not-Eaten	0.835	0.570	0.231	2.381	0.784	1.873	5.509	28.6	253.0

“The figures quoted afford a convincing explanation of the great differences which exist in the feeding value of pastures....”

On scanning the above Tables, it will be found that it is the percentage of ash that is determinative in the choice of fodder of the pastures. Those containing higher percentages are superior to those having lower percentage. The cattle also seem to appreciate correctly the value of feeds. It will be seen that the portion not eaten are invariably poorer in mineral value than the portions eaten.

Nearer home, in the provinces in India, in those places where the pastures are better in mineral-contents the animals are better. Pastures containing more lime, and the soil containing more lime, are the homes of the famous breeds of Madras.

706. Inter-dependence of mineral requirements : Calcium is one of the most important of the minerals. Ninety per cent of the ash of animal-body consists of calcium, phosphorus and sodium. As for calcium, two per cent of the body-weight of the cow consists of calcium oxide. Phosphoric acid closely follows calcium.

A general feature of the mineral requirement is the inter-dependence of one on another or on several others. The excess of one over the due proportion acts injuriously on the whole. The deficiency of one mineral similarly brings down the utility of another or several others. For example, there is some relation between the requirement of potassium and sodium. If the normal potassium : sodium ratio is disturbed

if there be an abnormal excess of potassium over sodium, then, not only will sodium refuse to be assimilated but potassium, though largely in excess of the requirement, will also be thrown out as unassimilable. But this assimilability is not governed by their mutual relation only ; the presence of other factors complicate the results. The group of the minerals represent almost a coloured woven pattern, one affects the other and is influenced by the rest and influences the rest. Deficiency of phosphorus will react upon calcium, making calcium un-assimilable. Again, an excess of calcium will react similarly ; yet, on the whole, an excess of phosphorus to a certain extent is conducive to calcium assimilation. Deficiency of sodium (common salt supplies sodium in the form of sodium chloride) induces all-round mal-nutrition and deficiencies. These can be corrected by a little addition of common salt to the fodder.

707. Value of balanced diets : Mitchel in an article on balanced diets (Science, 1934. P. 588 ; reprinted in *Indian Journal of Veterinarg Science and Animal Husbandry*, June, 1936) wrote :

“.. Carman and the author showed that the mere inclusion of one per cent of sodium chloride in a ration predominantly made up of corn increased its growth-promoting value by from 40 to 50 per cent in paired-feeding experiments with rats and chicks, without appreciably affecting its digestibility.”

Elsewhere in the same article, he wrote :

“... young rats placed upon a diet high in calcium, low in phosphorus, and deficient in vitamin D, will develop rickets, and the rate of development of this bone disease is the greater, the greater the daily consumption of the rachitogenoic diet. ...”

What was found in the experiment on rats was corroborated in the herbivora also, in matters of mineral deficiency. Deficiency of sodium is a standing cause of mal-nutrition in very large tracts of India.

708. Calcium regulates iron assimilation: It is also observed that the amount of calcium in diet affects the assimilation of iron. When there is plenty of calcium ingestion, less iron serves to satisfy the needs than when the reverse happens, and the supply of calcium is limited or deficient.

A deficiency of calcium has been found to induce defective absorption of sugar in the blood of rats. And, it is supposed that similar reaction also takes place in the system of the cow. (610)

709. Vitamin D regulates cal. phos. assimilation: Not only do the minerals act and interact amongst themselves but the excess or deficiency of other nutritional factors in a feed, such as protein or vitamins or total digestible nutrients, profoundly affects mineral assimilation. It may be stated that with deficiency of vitamin D, calcium and phosphorus refuse to be assimilated. The all-round action of vitamin A in animal-health is well-known, and a deficiency of vitamin A will react on the assimilation of the nutritive components in general.

In this tangle it is difficult and almost impossible to chalk out a clear mathematical line and say that so much of calcium, phosphorus, sodium, potassium and magnesium etc. is necessary for the maintenance of a cow of a given weight. Every attempt at finding out the requirement of a particular mineral will have to be guarded by the provision or presence of other nutritional factors in due or balanced proportions. The imbalance in one matter will affect the balance of many others.

With this reservation an attempt is made for indicating the requirements of the different minerals in a general way. The real requirement of a particular mineral must be solved with reference to any particular feed and the digestibility-trials of that feed. (612)

710. Acid-base character of mineral : Of the minerals some are acid radicles and some are basic radicles. Acid and bases are familiar terms and may be easily understood. Acid radicles are those that produce acids in combination with hydrogen or oxygen. Phosphorus, chlorine and sulphur are acid radicles. By combination with oxygen and hydrogen they form acid. Chlorine forms hydrochloric acid ; phosphorus forms phosphoric acid, and sulphur forms sulphuric acid. They may form many other acids ; some common acids only are mentioned here. The bases are substances which in combination with oxygen and hydrogen form alkalies. Calcium oxide is an alkali. Sodium, potassium and magnesium oxides are also alkalies. One property of alkalies is that they

combine with acid to form salts. Thus, calcium oxide (an alkali) forms with phosphoric acid a substance—calcium phosphate, which is a salt. The word salt here does not mean the table salt, but is chemically applied to substances arising out of the combination of alkali with acid. Common salt is also a salt formed out of the combination of the acid formed from chlorine called hydrochloric acid with sodium oxide, the alkali.

In nutritional experiments, recently carried out in Wisconsin, it has been found that when there is an excess of acid radicles, there is more rapid assimilation.

711. Some functions of minerals: The body-fluids contain minerals and these give them their characteristic properties. Blood also functions because of the presence of minerals. The acidity of the digestive juices are also due to the minerals. One of the most active enzymes of the stomach is pepsin, and pepsin can act upon the food materials for breaking up and making them digestible only in the presence of hydrochloric acid produced from sodium chloride or common salt, of which sodium is the mineral substance. The wonderful process of exchange between blood and body-fluids also takes place because of the presence of mineral salts.

The minerals help to keep the system in delicate acid-base balance. When this balance is disturbed disease and death may follow. The organ, kidney, functions very largely for keeping the mineral

balances in the system in proper proportion, by excretion of the unnecessary and excess mineral-contents of the blood. When the limit of the capacity of the kidney is reached, then there is a general break-down.

712. Minerals and frog's beating heart : The life-process goes on through the working of the fluids. Here again the importance of the mineral-contents of the body-fluids is illustrated by the common tests on the frog's heart in the physiological laboratories. If the still-beating heart of a frog is taken out and placed in a solution of common salt, the beats soon become progressively feeble, and soon stop. If, then a small amount of calcium salt is added to the solution the heart will begin to beat again. At this stage it is seen that unless a little potassium salt is added, the relaxations of the heart become feebler, and then stops in a contracted state. Potassium salt has to be present, and present in the correct proportion, with calcium and sodium. (609)

713. Sources of minerals in feeds : Minerals are ingested with roughage which vary very much in their mineral-content. A choice has, therefore, to be made for making up a suitable combination of various roughages. The legumes as green fodder are not only a rich source of protein but a rich source of minerals also. The deficiency of the minerals in roughages may be made up to a very considerable extent by the inclusion of leguminous roughages in the feed, although these are relatively poor in phosphorus.

The oil-cakes are also rich sources of minerals. Analysis Tables will show how rich some of them are.

Husks of legumes and pulses are also rich in minerals. The legumes and cereals are costly sources of minerals. But for growth and milk-production the protein of legumes becomes a necessity, and along with the protein they supply the minerals. Bones are supremely rich sources of calcium and phosphorus. Many a poor feed may be converted into satisfactory feed by the addition of bone-meal.

Common salt is a very easily available and much-needed source of sodium and chlorine. Even when other minerals and proteins are present in adequate quantities in a feed, sodium chloride will, in most cases, be found to be wanting. Common salt has to be fed to the cow regularly with the feeds.

Shells in powdered form may be used as a source of lime, so also powdered *kankar*. *Kankar* may be burnt into lime and then allowed to be slaked in the air and kept exposed to it with occasional raking for reaction of air on it. In course of time the caustic-lime gets shorn of its caustic property, being converted to calcium carbonate or chalk. It can then be used as a source of lime. Lime-stone powdered into meal also is a good source of lime.

Potassium is generally present in excess in feeds. It is a problem in most cases to find a fodder not excessively rich in potassium. Where, however.

potassium is deficient, wood ashes which contain a very large percentage of potassium will serve the purpose.

Magnesium is generally found in requisite quantities normally in the feeds. When there is, however, a deficiency, mineral magnesium in the form of magnesite may be used.

If iron is found deficient, iron oxide used for pigment may be added to the feed. Copper sulphate is a source of copper. For sulphur, sodium sulphate in *khari*-salt is an adequate source of supply.

714. Calcium-phosphorus requirements : There is calcium in body-fluids in the blood, and in the muscle juices. Calcium and phosphorus combine to form bones. Calcium in the form of calcium phosphate is the commonest compound in which calcium occurs in the system. Of the mineral-contents of milk half is made up of calcium and phosphorus.

Vitamin D is intimately connected with this couple ; calcium and phosphorus cannot be assimilated in the absence of vitamin D. But vitamin D is not difficult to feed. Fodder dried in the sun contains vitamin D. It can be manufactured in the animal system itself by exposure of the animal to sunlight. (610-'11)

715. Calcium phosphorus ratio : About their mutual interaction something has been said. Any large difference in their ratio is detrimental. In the animal-system they exist in the ratio of 1 : 1 or 2 : 1, or as a mean-ratio as $1\frac{1}{2}$ of calcium to 1 of phosphorus. When there is a great excess

of phosphorus or calcium, the balance is disturbed, and difficult consequences follow in spite of the presence in requisite quantities of other minerals. But, in the presence of very plentiful supply of each, with excessive ingestion of calcium, such as in the proportion of 6.5 parts of calcium to 1 part of phosphorus, dairy cows have been found to do well. (610-'11)

716. Calcium phosphorus on live-weights : The contribution of the German animal nutritionist, Kellner to the science of animal nutrition is great. In his "Scientific Feeding of Animals", he has given data regarding the mineral requirements of animals. According to him, for 2,000 lbs. live-weight the daily consumption of calcium and phosphoric acid are 100 grams and 50 grams. Converted to the requirement of a 500 lbs. cow (approximately one-fourth of 1,000 Kg.) the requirement of calcium could be taken approximately at 25 gram lime (CaO) and $12\frac{1}{2}$ grams phosphoric acid (P_2O_5).

Several other investigators in Europe and America have given figures approximating to the figures of Kellner's. In India several experiments were conducted at the Bangalore Institute and then at the Dacca and Krishnagar agricultural farms (Bengal), to find out the maintenance-requirements of the Indian cow.

Warth & Lander also carried out experiments on the digestibility of Indian fodders from which an idea of the requirements can be obtained. (610-'11)

717. Table of Bengal experiments on minerals :
 Carbery and Chatterjee in Bengal experiments found that a 500 lbs. bullock, when fed mainly on rice-straw, required the following quantities of minerals per day :

TABLE-49

Maintenance requirement for a 500 lbs. live weight.

(Carbery & Chatterjee, Talpatra)

Dacca--Bengal.

Lime	CaO	...	24 grams
Phosphoric			
acid	P ₂ O ₅	...	10 „
Magnesia	MgO	...	15 „
Potash	K ₂ O	...	70 „
Sodium	NaCl	...	32.05 „
—(610-'11)			

718. Lime requirement with rice straw feed :
 From these experiments 24 grams of calcium is to be regarded as the maximum maintenance requirement when rice-straw is fed. Rice-straw as a feed was also experimented upon at Bangalore. With a feed containing 24.91 grams there was a negative balance of CaO.

Negative balance means that the animal excretes more of the mineral than it is fed with ; the excess coming from the body tissues. Positive balance means that the animal excretes less than the intake of the mineral. The difference goes to be assimilated in the system, showing possibility of maintenance.

In a Bangalore experiment 16 grams of lime (CaO) in *joar* feed was found to give a positive balance. And in yet another series of experiments for 750 lbs. live-weight, 15 grams of CaO were found to give positive balance with *joar* hay, Aurangabad hay, Rhodes grass hay and Spear grass.

The interpretation of these figures with regard to the respective feeds is taken up later on. For the moment the optimum figures for calcium requirement of a 500 lbs. live-weight cow, may be put at 36 grams in case of rice-straw and less in case of other fodders. This is a little over the Bengal minimum but recommended by Carbery (Bengal) for safety in a rice-straw feed. (610-'11)

719. Bangalore experiment - lime requirement :

It is possible that as much as 36 grams CaO for the maintenance-feed of a 500 lbs. cow may not be quite necessary, except when fodders like rice-straw are concerned. Animals are likely to suffer from lack of calcium when fodders, poor in calcium, becomes the chief roughage. In a Bangalore experiment an intake of 41.37 grams of calcium gave practically a neutral balance, the actual figure being 0.08. In the same experiment, in an average of 5 experiments with *ragi* straw, an intake of 57.99 grams gave a positive balance of 2.3 grams of CaO . This is the average. But in individual experiments while 53.3 grams gave a positive of 9.9 gram CaO , in another 57.90 intake gave a negative of 2.35 (Warth. *Indian Journal of Veterinary Science and Animal Husbandry*, 1932. P. 328). These again indicate a much higher

requirement than the 24 or 25 grams considered to be the necessary minimum for rice-straw by the Bengal experimenters. In the same Bengal experiment, however, there were cases of rice-straw feeds to animals where as much as 47 and 55 grams of CaO intake failed to create a positive balance.

The very large difference between 24 grams arrived at as necessary in some Bengal experiments against negative balance even with an intake of 47 to 55 grams in the same series of experiments cannot be explained away. Some explanation has to be found, if we accept the figure of 24 grams of CaO requirement as held by Carbery and others to be the reasonable minimum figure. This matter is dealt with fully while considering rice-straw as a fodder. (796-807) At this stage, the oft-repeated fact has got only to be remembered that there is nothing like an absolute figure for a particular mineral or even anything near it. The action and inter-action of other factors in the feed govern the ultimate limit up to which calcium intake or for the matter of that any other intake has to be pushed to create a stable or positive balance. The quantities and forms of other minerals, the presence and absence of vitamins etc., all affect the requirement. (610-'11)

720. Fodders and lime intake : Calcium occupies a very important place among the minerals in animal nutrition, and calcium balance has to be kept positive. This may not be achieved in some cases by any amount of intake of calcium through a particular

fodder till the factors contributing to make calcium balance a negative one are attended to and rectified, in other words, till the feed is made into a square ration. With these limitations we may, for the present, accept ordinarily calcium (CaO) requirement to be at 36 grams per 500 pounds live-weight, as recommended by Carbery, for optimum, and 24-25 grams as minimum. There will be exceptions, according to cases. (610-'11)

721. Requirement of phosphorus : Calcium and phosphorus combine to make bone which is mainly a compound called calcium-phosphate. Ninety per cent of bone consists of calcium-phosphate.

These two minerals, calcium and phosphorus, together constitute three-fourths of the total mineral constituents of animal body. Of the minerals of milk, calcium and phosphorus constitute more than half.

In the life-process these minerals are used up and excreted daily. Sufficient amounts should be taken in to make up for the daily loss. In the case of growing and lactating and pregnant animals, liberal supplies are necessary to meet the increased need. Even for maintenance, if a sufficient quantity is not taken in to make up the daily loss the system will suffer. (610-'11)

722. Calcium and phosphorus in due proportion : In this connection it should be remembered that not only should calcium and phosphorus be present in appropriate proportions but along with them the presence of vitamin D also (and, of course, of A) is

necessary so that these minerals may be effectively utilised in tissue-making.

Calcium and phosphorus deficiencies are common in the usual roughages, and the mal-nutrition of cows on account of their deficiency is also very common. Care, therefore, should be taken to see that they are present in sufficient quantities in the feeds to meet both maintenance and production and growth requirements. (610-'11)

723. Phosphate and leguminous fodder : The leguminous concentrates or pulses are rich in calcium as also the leguminous hays or leguminous green fodder. Non-leguminous fodders contain much less calcium than the leguminous ones. Most of the roughages are low in phosphorus. Legume hays are not much richer in phosphorus than the common grasses. The stalks of cereal grains are very poor in phosphorus. Cereal grains are low in calcium but fair in phosphorus-contents.

724. Bone-meal for calcium and phosphorus : As we may look to the leguminous hays for calcium, similarly we may look to the protein-rich oil-cake concentrates for phosphorus. Wheat-bran is specially rich in phosphorus. So also is rice-bran rich in phosphorus. But this phosphorus of rice-bran (827) is in an indigestible form, and, therefore, of little use as a feed. Bone-meal is rich both in phosphorus and calcium and it contains a high percentage of protein. It has 32·6 per cent calcium, 14 to 15 per cent phosphorus, 7 per cent protein, and 3·3 per cent fat. It has been found that for a 500 lbs. live-weight

10 to 11 grams of phosphorus (digestible) will do. Phosphorus in some excess helps the assimilation of calcium and other nutrients. Although any very high disproportion of phosphorus to calcium is undesirable, $1\frac{1}{2}$ parts of calcium to one of phosphorus has been recommended. But 2 calcium to 1 phosphorus has been found satisfactory in many instances, while cases are not lacking where 6:1 ratio of calcium to phosphorus have been known to be entirely satisfactory.

Taking calcium to be 30 or 36 grams, we should suppose that 15 grams of digestible phosphorus in feeds for 500 lbs. live-weights are a satisfactory basis. (607)

725. **A study of some analytical figures of nutrients and minerals :** At this stage it is worth while to take up some typical fodders and study their character as revealed by analysis and their suitability as feeds. A total consideration of the feed-values regarding all minerals and vitamins is not attempted here. We have got some idea of the requirements for carbohydrates and proteins, and of calcium and phosphorus amongst minerals. We have some more items to consider, for example, the requirements of the other important minerals like potassium, sodium, and magnesium, of the various vitamins, and also of the inter-action of the various minerals and nutrients on one another. But before we go so far, it is necessary at this middle stage to take stock of the materials hitherto treated and utilise them for judging the place of some fodders, however incomplete such a survey may be.

726. Maintenance requirement of a 500 lbs. cow :

So far we have seen that for mere maintenance of a 500 lbs. cow, the following nutrients are necessary :

Digestible protein	...	0.33 lb.
Starch equivalent	...	3.05 lbs.
Calcium as CaO	...	25 grams minimum—
	...	36 grams optimum.
Phosphorus as P ₂ O ₅	...	15 grams.

For the common feeds all over India, the Punjab excepted, the straws from cereals are depended upon as the main fodder. These cereals vary according to locality. All over India, however, Rice, Wheat, *Joar Ragi*, *Bajra*, Maize, Barley are the principal food-grains. The stalks or straws left over after collecting their food-grains form the main dry roughage. An analysis of the digestible proteins, starch equivalents and of the minerals, of calcium and phosphorus contents or some of these are given below, to get at their nutritive values. Although they form the main feeding-stuff, animals cannot exist only on them as single fodders, neither are the cattle kept singly on them in practice. Some green grass or green fodder, however small be the quantity, is fed. Without green fodder there will be no vitamin A, and without vitamin A no nutrients can, for any long time, keep an animal in health. (648)

727. Digestibility trial conditions ; It has been the practice in digestibility trials in India to keep the animals first entirely on a life-less and practically protein-less dry feed to determine the mineral

requirements on single feeds. At the next stage, some concentrates are given, and at the third stage, both concentrates and some green fodder are given, and the mineral requirements at these three stages of feeding are determined. This has been the case with the two series of Bangalore experiments conducted by Warth and Iyer (1932-34) and with the Bengal experiment by Carbery and Chatterjee (1937). In the Lyallpore experiment by Lander and Dharmani (1931) the third stage was not taken up. These experiments (808-'12) cannot serve as guides, being void of practical utility.

728. Constructing a ration : In trying to find out how the common feeds answer to our requirements, a more realistic choice has to be exercised. In chalking out the feed requirements of the four items of protein, energy, calcium, and phosphorus, an attempt is made to show in skeleton form what would be amenable to development as a practical feed and not as a mere academic thing. The feeds, therefore are intended to be made up of (a) dry straws or stalks which go mainly to supply a portion of the energy needs ; (b) green grass which will go to supply some protein, some minerals and vitamin A ; (c) an easily-available common concentrate for the supply of some protein and phosphorus.

729. Table of nutrients in some feeds :

TABLE—50

	Digestible crude protein. %	Total digestible nutrients. %	Nutrition ratio. %	S. E. %	CaO %	P ₂ O ₅ %	MgO %	Na ₂ O %	K ₂ O %
<i>Dry roughages—</i>									
Rice straw ...	0.00	50.23	...	32.2	0.40	0.14	0.28	0.50	1.63
Wheat straw ...	0.00	48.95	...	24.3	0.42	0.51	0.11	0.28	1.25
Joar straw ...	0.64	51.59	74.8	27.0	0.38	0.23	...	...	...
Ragi straw ...	0.23	55.63	243.5	34.7	1.11	0.16	0.45	0.26	1.5
Bajra straw ...	1.5	42.5	27.3	30.0	0.55	0.44	0.33	0.13	2.96
<i>Green fodder—</i>									
Dub grass matured, (dry equivalent)	5.0	46.78	10.5	34.0	0.77	0.59	0.34	0.23	2.08
<i>Concentrate—</i>									
Linseed Cake...	25.74	71.8	1.8	82.6	0.52	2.20	0.98	0.47	0.92

Out of the various straws from cereals let rice-straw be chosen as the main roughage.

For a live-weight of 500 lbs., the maintenance requirements of the four items (a) digestible proteins—33 lb.; energy—3.05 S. E.; CaO—25.36 grams; P_2O_5 —15 grams, have already been mentioned in Para 726. The above demand has to be met from rice-straw in combination with, for instance, green *Dub* grass and a concentrate, linseed cake. At the very outset there is the limit to the quantity of dry matter or equivalent of dry matter that can be fed. At two per cent of live-weight (500 lbs.) this works out at 10 lbs. This has to be distributed amongst the three items of feed.

730. A trial ration : For a beginning let us try with the following :—

Rice-straw	...	...	8 lbs.
Dub grass green	6 lbs.		
equivalent to dry grass	...		2 lbs.
Linseed cake	...	...	$\frac{3}{4}$ lbs.
Total			<hr/> 10 $\frac{3}{4}$ lbs.

Such distribution will be approximately within the total dry-matter limit, and it is believed that a healthy cow shall be able to eat the quantity of palatable concentrate with the addition of some salt.

731. Nutrients available in the ration : The nutrients which the animal will receive from the feed, according to analysis in the Para 927, will be as under :

TABLE-51

		(1) Digestible crude protein. lb.	(2) S. E. lb.	(3) CaO gram *	(4) P ₂ O ₅ gram
Rice-straw	8 lbs.	nil	2.5	16	5.6
Dub grass dry equivalent	2 lbs.	0.1	0.68	8	6
Linseed-cake	$\frac{3}{4}$ lb.	0.18	0.6	1.9	8.2
Total	10 $\frac{3}{4}$ lbs.	0.28	3.78	25.9	19.8
Requirement according to schedule—	10 lbs.	0.33	3.05	24.0	15.0

732. Scanning the trial ration: On an examination of the above Table it will be observed that the total dry-matter exceeds by $\frac{3}{4}$ lb., which is a negligible quantity for practical purposes. A cow in health, with appetising food, can take more than 2 per cent of her weight of dry-matter if she chooses to do so.

Digestible crude protein shows a negative difference of .05 lb. This also is a negligible quantity. It would have been better if more protein could be included.

Starch equivalent shows a positive difference of .73 lb. This would rather help maintenance than detract from it.

Calcium (CaO) shows a positive difference of 1.9 grams from the minimum standard set for it.

* Calculated at 450 grams to the pound.

Phosphorus shows a positive difference of 4·8 grams. This is a great asset. In fact, this is a determining factor in the sum total of the assimilation of nutrients. It is largely in excess proportionally of the calcium intake. This excess will be wholly for the good. Here it indicates to us the possibility of utilising a concentrate poorer in phosphorus than linseed or any other oil-cake, at the same time a concentrate that will not fall short of the protein requirement.

733. Various straw feeds : The reader may work out probable feeds with other cereals, grasses and concentrates. It will be seen on an examination of the Table No. 50 that wheat-straw is as bad as rice-straw in its content of digestible crude protein. Its protein is wholly indigestible like the protein of rice-straw. The other straws are a little better, but analytically their digestible protein contents are almost negligible, with *bajra* at 1·5 per cent as a relieving exception. Next to *bajra* stands *joar* with 0·64 per cent. *Joar* is a much better fodder than rice-straw, though it is poorer than *bajra* both in calcium and phosphorus.

Ragi straw is rich in calcium being the best in the group with its 1·11 per cent. The one next best to it is *bajra* with ·55 per cent which is nearly half the percentage content of *ragi*-straw.

Straws or stalks are bad fodders in as much as they are poorer in the three essentials of nutrients—protein, phosphorus and calcium. But it is no use finding fault with them. As we are situated, we have to make the best use of them, knowing the poor value

of their constituent nutritional factors. The proper outlook should be to use them with the necessary correctives. We shall go into the matter of correctives when we know more of the fodders in general.

734. Place of legume hays : It may be mentioned here that the hays from leguminous crops are much richer in protein. In fact, in protein alone some of them approach some of the concentrates. They are, however, very poor in phosphorus, which, if necessary, can be artificially made up. If, for example, a rice-growing province understands the importance of feeding leguminous fodder for making up digestible protein which is practically absent from rice-straws, then the feeding problem at once takes a better and a vastly more promising turn. That will partly do away with the necessity of feeding concentrates, merely for maintenance purpose.

735. Reconstructing the ration : If, for example, a leguminous fodder is chosen which has near about 12 per cent digestible protein, as many leguminous fodders have, then double the quantity of cake or $1\frac{1}{2}$ lbs. of dry fodder will serve the purpose of the $\frac{3}{4}$ lb. of oil cake. In that case, $\frac{3}{4}$ lb. or 1 lb. may be taken off from the rice-straw, and in place of the $\frac{3}{4}$ lb. cake may be added $1\frac{1}{2}$ lbs. of a leguminous hay. That will keep the protein-need practically fully maintained. But oil-cake is not only rich in protein, it is rich in phosphorus also. Legume hays are poor in phosphorus. But as we had a good excess of phosphorus in hand, legume hay may just fit in. Some of the legume hays left after harvesting are

quite rich fodders, and it is worth while to see how some of them might fit in.

736. Concentrate substitution by hay : Percentage composition of some legume hays :

TABLE-52

Hays.	Digestible protein per cent. lb.	S. E. lb.	CaO lb.	P ₂ O ₅ lb. per cent
Berseem hay	10.29	47.3	2.07	0.65
Cowpea hay	10.33	29.6	2.27	0.40
Ground nut hay	14.93	33.8	2.54	0.42

1½ lbs. of the hays will give—

Berseem	1½ lbs.	0.15	0.7	0.03	0.01
Cowpea	1½ lbs.	0.15	0.4	0.03	0.006
Ground-nut	1½ lbs.	0.22	0.5	0.03	0.006

737. Straw grass and legume hay feed : If the three-fourth pound of oil-cake be replaced by 1½ lbs. of a legume hay, say ground-nut hay, and if the rice-straw feed be reduced by one pound, the new feed composition stands as under :

TABLE-53

		Digestible protein. lb.	S. E. lb.	CaO gram.	P ₂ O ₅ gram.
Rice straw	7 lbs.	...	2.2	14	5
Dub grass	2 lbs.	0.1	0.68	8	6
Ground-nut hay	1½ lbs.	0.22	0.5	15	3
Total available—	10½ lbs.	0.32	3.58	37	14
Requirements :	10 lbs.	0.33	3.05	24	15

The new total has come up to $10\frac{1}{2}$ lbs. of dry-matter which is within the margin. Digestible protein is also within the limit of requirement, and so is starch equivalent. Calcium has gone considerably up by the change while phosphorus stands just near the optimum limit.

By this replacement of $\frac{3}{4}$ pound of concentrate by $1\frac{1}{2}$ lbs. of legume hay, the net result looks considerably improved and the cost will work out cheaper, which is a great consideration.

The above serves as an example of the way of thinking out a probable mixed feed for maintenance according to the locality. To the cereal crop of the locality one will have to look for the main roughage. Next, as much as possible of green grass, or any green fodder should be sought for. Here there is a margin for considerable improvement by cultivation of suitable fodder-crops and feeding them in a green or silaged state. Next to these, legume hay fills the picture.

After having gone into the question of requirements of the two minerals, calcium and phosphorus, we stopped to utilise the knowledge for drawing up a feed suitable for the maintenance-requirement of an animal of 500 lbs. live-weight. This has now been accomplished.

The other minerals have now got to be taken up one by one.

738. Sodium and potassium and chlorine requirements: It is a peculiar fact that the body requirement of sodium in herbivorous animals is often

greater than the quantities which they usually obtain from their feeds. Unless, therefore, sodium is got from non-vegetable sources, there is a constant and persistent hunger for it. The flesh-eating animals do not suffer from this difficulty. They live on flesh which gives them the required quota of salt. Where the soil is markedly alkaline, there may be little difficulty for the animals in procuring salt. The plants there contain sufficient quantities to meet the need.

739. Sodium chloride or common salt : Sodium chloride or common salt has sodium and chlorine in it, and both sodium and chlorine are necessary to maintain that state of pressure of body-fluids in which they are able to permeate through the membranes to react on materials outside of it. The transfer of nutrients to the body-cells and of waste-products from the body cells depend upon this peculiar state of pressure or osmotic pressure of body-fluids. Sodium chloride is an essential material in maintaining this osmotic pressure, although other mineral substances are also necessary, and sodium chloride merely will not serve the purpose long.

The chlorine part of sodium chloride serves the purpose of forming hydrochloric acid, the substance of the digestive acid-juice of the stomach. Blood contains sodium chloride. The share of common salt in blood is greater than that of any other mineral. Blood tastes of salt. Sodium chloride, after discharge of its various functions, is excreted out of the body in urine and particularly in the

sweat of the body. Sweat is rich in salt. A cow will lick another's body for the sake of the salty taste of sweat.

740. Importance of salt : Physiological experiments with frog's heart prove (712) how necessary sodium, calcium, potassium and chlorine are for the heart to function. Not only must these be present, but they should be present in their proper proportion. When common salt is denied to a cow she will ordinarily preserve her health a long time without showing any marked change. She will economise her supply and excrete it less with urine. But after a time the result of sodium chloride starvation will be manifest in mal-nutrition and break-down.

It has been observed that when there is much perspiration, much salt is thrown out and there is exhaustion. If, at that time, water containing salt is drunk, there is less exhaustion. Perspiring animals should, therefore, be given salt-water drinks after hard work.

The quantity of common salt needed depends upon the quantity of potassium present. If the sodium-potassium ratio is broken, then, in spite of sufficient intake, both will starve the system and be excreted out. As a matter of fact, it is the excess of potassium over sodium that does the mischief. Excess of sodium has not been found to produce a similar effect.

741. The problem of potassium : With regard to potassium the problem is how to keep down its

proportion rather than supplement it. In the ordinary feeds, there is often too much excess of potassium. The cereal-straws contain too much of it and the legume hays contain more, often one and a half times the content of cereals. Hays rich in protein are generally gifted with very high potassium content. So, there is little chance of potassium requirement falling short of the needs. On the contrary, watch has to be kept that the percentage of potassium does not go up too high. If it is unavoidably high, a remedy is sought by increasing sodium chloride intake proportionately.

742. Ensuring sodium sufficiency : It has been found in practice that the best way to ensure sufficiency of sodium is to add salt to the feeds to the extent of three-fourth ounce to two ounces per day according to the nature of the feed, and leave the animals to satisfy any deficiency by keeping blocks of rock salt in places to which the cattle may have free access so that they may lick them whenever they desired.

743. Iodine requirement : A quantity of iodine, though very small, must be present in the feeds to meet iodine requirements. Localities far removed from the sea generally run the risk of having iodine deficiency. There are special areas where iodine may be deficient. Iodine deficiency causes goitre, specially in the new-born ones. Where this is observed, the remedy lies in supplying minute quantities of potassium iodide with the feed. Two drams (120 grains) or $\frac{2}{3}$ rd *tola* of potassium iodide

may be mixed with one maund of salt to be served in the usual way of serving salt with the daily feed.

744. Iron and copper requirement : The sum total of iron in animals is very negligible. In a healthy man, there are at any time only 43 grains of iron, an insignificant quantity. A little amount of iron in the animal-body has a great effect on the life-process. The blood corpuscles contain haemoglobin that has iron as one of their ingredients. There is, therefore, ever so little iron in every corpuscle of blood. This microscopic quantity of iron serves the very useful purpose of helping the absorption of atmospheric oxygen by which blue veinous blood is converted into red arterial blood. Iron is also present in the body-cells.

Recent experiments at the Wisconsin Station (U. S. A.) have gone to prove that copper is also needed in the system to make iron perform its function. It acts by its mere presence. It has already been mentioned in connection with calcium that it profoundly affects the assimilation of iron. If there is no copper in the system iron is unable to function, and anaemia will result, in spite of the intake of iron in the feed. In the absence of copper, iron gets stored up in the liver and does not contribute towards the formation of haemoglobin.

There is generally sufficient iron and copper in the usual feeds of cattle. Where, however, there is too little iron and copper in the herbage, the cattle cannot thrive. It was known that cattle cannot thrive in certain tracts of sandy land in Florida. These lost

appetite, got emaciated and their haemoglobin of blood fell below normal. They got stunted and many died of disease. It has now been found that the disease is really a deficiency disease due either to the absence of iron or both of copper and iron. A mixture consisting of 25 lbs. of red oxide of iron and one pound of finely-ground copper-sulphate was mixed with 300 lbs. of common salt. Precaution was taken to so uniformly mix the stuff that the composition was the same at any place, and that copper poisoning might not happen by the excess of copper sulphate. The animals were allowed to take a portion of this mixture daily. The whole herd thrived. This newer knowledge may serve humanity in several diseases involving anaemia which can be accounted for and handled.

745. **Assimilation of inorganic iron :** These Wisconsin experiments have brought out another factor. It was so long believed that mineral iron or iron salts cannot be assimilated in the system when presented in an inorganic form and that only organic compounds of iron can serve to make up the deficiency. But now, it has been proved that it is the organic iron found in plants which is more difficult of assimilation, for it needs breaking up before absorption. On the contrary, the inorganic iron salts are easily assimilated if the requisite quota of copper-sulphate is administered with it. It was also found that organic iron in the cereal grains was not as available for haemoglobin building as that in inorganic salts. This newer knowledge of the suitability of inorganic iron for

assimilation has been utilised in the cure of iron deficiency in young suckling pigs.

746. Experiments with pigs: Pigs which were fed unusually long on their mothers' milk, a substance deficient in iron, developed deficiency diseases due to the shortage of iron and copper in the milk. Of a pair of newly-born pigs one was left with the mother in a paved enclosure without access to earth or fodder. The other was taken to another sow whose udders were bathed in a solution of iron sulphate daily. The one that was removed showed normal growth for having taken the iron sulphate solution of the wash of the udders. The other one suffered from severe anaemia.

747. Mothers' milk and iron: It has been observed that calves, kept inordinately long on mothers' milk, were likely to develop anaemia. Mothers' milk is poor in copper and iron. Before birth the mother puts in so much iron in the system of the foetus in the uterus that after birth and during the normal period of dependence on the mother's milk, the reserve of iron and copper serves the purpose of maintaining normal development. If, however, a calf or a human child is made to depend on the mother's milk longer than is normal, then provision must be made for supplying supplementary iron and copper; otherwise the young ones will not thrive.

748. Sulphur requirement: Sulphur is an essential element necessary for the production of the important sulphur-containing proteins called cystine. Normal fodder contains sufficient sulphur for the

ordinary needs. When sulphur shortage is apprehended, inorganic sulphur in the form of raw sulphur or in the form of sulphates may be given, though their utility is doubted. *Dub* grass contains sufficient sulphur. This may be increased in the feed. A list of the sulphur-contents of fodder grasses is given with the Analysis Tables in Para 934.

749. Magnesium requirement: Magnesium is necessary for nutrition, and its absence causes disaster. Fortunately, however, generally all feeds contain sufficient magnesium and its deficiency is not apprehended.

In the Bengal experiments (717, 808-'12) a positive balance was found to be established when the intake stood at 15 grams for 500 lbs. live-weight. The dietary requirements of magnesium is, however, assessed to be very low. Green doubts whether magnesium-deficiency diseases would ever be found to occur naturally in farm animals.

Precaution has to be taken the other way. Excess of magnesium may be ingested, and this is likely to cause poor assimilation of both calcium and sodium. Rice-*kura* (bran) (815, 827) contains an excessive quantity of magnesium, having 2·6 per cent of dry-matter. Rice-*kura* is used as a concentrate feed. It may act harmfully, if any but the smallest quantities are fed. Magnesium fed in large quantities for a long time results in weakening the bones, leading to a disease known as 'bran disease.' This agrees with the theory that magnesium in excess causes increased elimination of calcium.

Manganese and Boron are necessary in very minute quantities and they are usually present in all common feeds, and no particular attention need be paid to them, although their absence will cause deficiency-diseases.

750. Vitamin requirements: general consideration: The number of vitamins is growing as investigations are progressing. Six of them A, B, C, D, E, G, have definite masses of information about them. Vitamin K for the poultry has been added to the list of the definitely-established ones. B is regarded as a complex vitamin yielding 6 different vitamins, and what was named B₂ is now named G.

Of all the vitamins, A and D vitally concern the veterinarian. These affect all classes of stock-animals and are of great importance in the matter of stock-feeding. The other vitamins are found plentifully in rations fed to the stock.

Between the years 1911 and 1913 the importance of vitamins A.B.C. in nutrition and in the working of the life-processes was found out. Pigs born just before winter or in autumn used to get diseases like paralysis or pneumonia in America, and a large number of them used to die. This was due to the seasonal deficiency of essential vitamins in the feeds. This was not known at the time, and there was no remedy for this illness and the deaths. After the discovery of the vitamins the causes have been understood, and the problem of the death of pigs born in autumn does not trouble the stock-breeders of the affected tracts of America.

The stock fed exclusively on cotton-seed meal, as concentrate, did not thrive. Deaths occurred which were at the time known as "cotton seed meal poisoning." The disease was due to deficiencies of vitamins and minerals. They have been corrected and cotton-seed meal stands today as one of the most prized of concentrates, although it was a dreaded article only a few years ago.

These discoveries have solved and are still solving many intricate nutritional problems. It is a pity that researchers in vitamins have given their attention primarily to human food. It is only on a few items of fodder that there is definite knowledge of their vitamin-contents. Even those few about which such knowledge has been obtained are fodders grown in countries of the researchers outside India, and, therefore, are of little value to the stock-keeper in India. Indian fodders are still waiting the attention of researchers in India. The work done upto now in India, though valuable, is very meagre.

Vitamin-contents vary according to season and soil in the same fodder. From the published Tables a guess may be made about the vitamin-contents of Indian fodders. (612)

751. Vitamin A: In the nutrition of cattle vitamin A takes a place of unequalled importance. It is necessary for maintenance, and more necessary for growth and lactation. Unless a sufficient amount of feed, rich in vitamin A, is fed, disaster is sure to follow. Vitamin A used to be called the vitamin for growth. But this circumscribed idea about the utility of

vitamin A has now been discarded. It not only affects growth but it affects cattle in all the phases and aspects of their life. (612)

752. Functions of vitamin A : One of the chief functions of vitamin A is to keep the surface tissues of membranes and of the skin in a healthy condition, so that bacterial invasion may be resisted. Deficiency of vitamin A so weakens the power of resistance that bacteria can invade the body readily. The internal organs have membranous coverings. When the coverings of any organ are affected, disease of that particular organ commences. The respiratory system is, for example, full of membranous surfaces. Lack of vitamin A will invite disease to the respiratory system. (612)

753. Vitamin A and blindness : Disease-creating bacteria are in the air, and they find their entrance into the lungs. Diseases of the respiratory system may result on account of vitamin deficiency. Keratomalacia or xerophthalmia is a disease of the eye. It is due to injuries to the mucous membranes of the eye. These membranes cannot resist bacteria in case of vitamin A deficiency; infections occur which eventually lead to blindness. It is not the resisting ability of the mucous membranes alone that is undermined by vitamin A deficiency. The nervous system is affected and the retina is affected also. In some experimental stations in America, sows were fed with a ration void of vitamin A. Pigs were born there, which, as a consequence of the deficiency, were without eye-balls. In another place in America,

cows were fed with rations poor in vitamin A. There were deficiencies of minerals also. This resulted in the blindness of the calves. Normal calves, reared on rations deficient in vitamin A, also became blind. In these cases the optic nerves were affected. It should be noted that in these particular cases, vitamin A deficiency was not the only cause, for even after the correction of the vitamin deficiency some calves still went blind. There were other contributory factors.

When cows are fed on low vitamin rations for a time disaster generally follows. The calves are born dead or so weak that they die soon after birth. Occasionally the cows abort long before their calving time. After calving the cows fail to come to heat until green feeds become available. Young cattle suffer seriously for vitamin A deficiency. They improve when feed rich in vitamin A is given, unless they are very seriously run-down. Vitamin A deficiency may cause paralysis. Young and growing animals have greater need of vitamin A and, therefore, suffer more from its deficiency. (612)

754. Storage of Vitamin A : Vitamin A can be stored in the liver and other tissues ; and, therefore, when there is a deficiency in the feed, this reserve is drawn upon and no evil effects may be felt so long as the reserve lasts. When more than the necessary vitamin A is supplied, the extra supplies go to the reserve. (612)

755. Sources of Vitamin A : The commonest and the most wide-spread source of vitamin A is the

green part of plants : green leaves and green stems. Cows on good pasture give the highest yield of vitamin in their milk. Milk responds to the vitamin A reserve of the milking-animal. When fodder is rich in vitamin A, the milk also is rich in vitamin A. When a cow is fed on rations lacking in it there will be no vitamin A in the milk or the quantity present will be insignificant. A milch-cow on fodder in which there is no vitamin A will run the risk of her life, as well as that of her calf.

The yellow colour is associated with vitamin A. As a matter of fact, it can be manufactured out of carotene in the body of the cow. But it should not be concluded that the depth of the yellow colour is a measure of carotene, and that the more the yellow, the more carotene is there. There are some cows which give colourless butter, which contains its full share of vitamin A, but probably no carotene. Vitamin A is a colourless body which can be made out of the yellow carotenes of fruits and leaves etc. Many cows convert carotene partially, others fully into vitamin A. Therefore, the absence of yellow colour in milk or butter does not necessarily mean a deficiency of vitamin A, as the whiteness may be due to the more complete conversion of carotene. Generally speaking, however, white butter fats are poor in vitamin A and in carotene-contents. (612)

756. Carotene : Carotene is a yellow-coloured fat-soluble substance, occurring in the yellows of carrots or of butter-fat. In plant life, all or nearly all vitamin is in the shape of carotene, invariably found

in green leaves. Carotene itself is yellow but its yellow is masked by the deep green colour of chlorophyll. When, on uprooting a plant or on plucking a leaf, the green is bleached out by the action of the sun's rays, the yellow appears. Animals taking green fodder secure an abundance of carotene. When, however, green fodder is allowed to dry, carotene is destroyed, partially or wholly. If fodder is dried in the shade without fermentation in such a way that its green colour is maintained, then much of the carotene is preserved. In dried hays, the amount of carotene may be regarded as proportional to the greenness of the fodder. In silage, to the extent the green colour is retained, the carotene also is retained. As a matter of fact, ensilage allows much of the carotene to be retained and is, on this account, superior to dry cured fodder. With the exception of carrot, yellow roots and tubers do not contain carotene to any appreciable extent.

Vitamin A is fat-soluble and, therefore, all the vitamin A of the milk is in the fat. Skimmed-milk may contain only a negligible quantity of vitamin A. The yolk of eggs and the livers of animals and fishes are excellent sources of it. (612)

757. Vitamin B: Vitamin B is an water-soluble substance and is known as the anti-beri-beri vitamin. Highly-milled products from which the outer coat of the grain is taken away retain little vitamin B, so that when such grains become the staple food of the people, the deficiency-disease of beri-beri, due to want of vitamin B, occurs.

Vitamin B is widely distributed in plant life and, therefore, there is little danger of herbivorous animals receiving vitamin B-deficient fodder. It is present in straw and in hay, whether green or not. Yeast is particularly rich in vitamin B. It has been found that it can even be synthesised in the paunches of ruminants by the action of bacteria. (612)

758. Vitmin B complex : Vitamin B is now regarded as a complex substance, the components of which are all water-soluble and resistant to high temperature and to oxidation, although they can be destroyed by prolonged heating at the boiling temperature of water.

Vitamin B₂ complex is now separately named as Vitamin G, which consists of two factors—flavin which is required for growth and nicotinic acid. It is the nicotinic acid that prevents skin-diseases and also prevents pellagra in man. It is not exactly known whether the other components of B complex are of any importance or not. Vitamin B is so stable that paddy, stored in a dry climate for a hundred years, retains it. (612)

759. Vitamin C : Vitamin C has been definitely separated in a crystalline form and has been identified as the substance now known as ascorbic acid. Vitamin C is an anti-scorbutic agent. It is soluble in water and is contained in green leaves and fruits, particularly in sour fruits. Men, monkeys and guinea pigs cannot synthesise vitamin C, and, therefore, when no green substance is supplied with the food, they suffer from scurvy, a vitamin C-deficiency disease. In scurvy the

teeth are loosened, the gums get inflamed and the bones get brittle, the wounds become slow to heal, and loss of vigour and death ensues. Many people in long voyages developed scurvy and succumbed to it. In Europe and America scurvy was, at one time, a common disease. But now, it is becoming rare because it has been generally known that scurvy is a vitamin C-deficiency disease, and that this vitamin is obtainable in orange, citrus, tamarind or tomato juices. The disease may be prevented by adding a little of the raw juice of these fruits with the daily food, and if the disease occurs, these juices can cure it in the early stages.

Farm animals can synthesise vitamin C and, therefore, they do not suffer from this deficiency. It has now been found that human infants up to about 5 month of age can synthesise vitamin C. After that age, they lose this ability. (612)

760. Vitamin D: Vitamin D is vitally necessary for cattle. Cattle can synthesise this vitamin in the presence of sun-light.

It is known as the anti-rachitic vitamin, because in its absence rickets attack human beings and cattle. Vitamin D acts by its presence, and makes the assimilation of calcium and phosphorus possible. During the period of development of the cattle, it is particularly necessary. Pregnant mothers require it for the growing foetus, for the formation of bone from calcium and phosphorus. Milk contains large quantities of phosphorus and calcium and, therefore, during lactation, vitamin D is particularly necessary

for the assimilation of these two minerals from the feed.

Just as the discovery of vitamins has stamped out scurvy, similarly the discovery of vitamin D has saved innumerable children and also the young of the live-stock. Only a generation ago, 80 per cent of the children in the large cities of Europe and America used to have rickets to a more or less extent. But rickets is disappearing now.

It was discovered in 1924 that certain substances could develop vitamin D in them by exposure to ultra-violet rays. In the skin there are minute traces of a substance called ergosterol. Sun-light acting on this formed vitamin D. Even diffused day-light has the property of forming it from ergosterol in animal tissues. When live-stock are allowed to have sunshine, they generate it for themselves.

Vitamin D is soluble in fat but is not destroyed on prolonged heating at the temperature of boiling water. Dry fodder, cured in the sun-light, contains it. Green plants have no vitamin D. It is formed during sun-drying. Milk has vitamin D in its fat. Egg-yolk has plenty of it. Fish liver and fish liver-oils are particularly rich in it; fish meat also contains it. (612)

761. Vitamin E: This vitamin is widely distributed in fodders and in those human foods that have not been artificially refined. Vitamin E is abundant in cereal grains, in seeds and in vegetable oils. It is particularly rich in the germs of seeds. It is present in green leaves and in hay. Lack of

it in female rats causes sterility. The female rats conceive, but in the very earliest stage the foetus dies and is absorbed for lack of this vitamin. In male rats also this deficiency brings about sterility. What is true of rats is not applicable to all mammals. It is not definitely known how far cows require vitamin E. Even if it is required, it is amply provided for in the usual feeds. (612)

762. Water requirement: Water is of the utmost necessity in the nutrition of animals. Water is evaporated from the skin, it escapes through the breath and also largely through urine and faeces. All these losses have to be replenished. The animal itself produces some water during the metabolism of its food. For example, 100 lbs. of carbohydrates will yield 55.5 lbs. of water and 163 lbs. of carbon-dioxide. The proteins will yield a little less water than carbohydrates. Animals get some moisture even with the dry feeds. Green feeds are particularly heavy carriers of water.

If enough water is not supplied, the milk-yield of cows gets lessened. The milch-cows require the largest amount of water, for water forms 87 per cent of their milk. According to size, a cow may take 5 to 12 gallons of water daily. Cows require 4 to 5 volumes of water per volume of milk alone. Water should be available in a pure and clean condition, always in the byre. When animals are kept loose, water troughs should be provided where they may have their fill. In stall-feeding every animal should have a water trough or every pair may be provided

with one trough if properly arranged or there should be a row of common water troughs accessible to all. Where cows are taken out for drinking in streams, it should be done twice daily.

Water serves another purpose, namely, the control of the body temperature ; when the body temperature goes up, a drink of cold water helps to bring down the temperature and allay the discomfort.

763. Air requirement : When the air is inhaled it reacts on the lungs and gets altered. Four per cent of the volume of air is taken away in the form of oxygen and is replaced by four per cent of carbon-dioxide in the process of breathing. Air entering the lungs has 21 per cent oxygen. Four per cent is taken out of it in the purification of the blood in the lungs, and the exhaled air contains only 17 per cent oxygen. In the air taken in, there is only .03 per cent of carbon-dioxide which increases to 4 per cent. Continual inhalation and exhalation will go on if animals are confined in a closed box and the confined air will soon be unable to support life. When men congregate, when there are many men in a closed space, the people are oppressed with a stuffy atmosphere. At one time it was believed that this was due to the over-loading of the air with exhaled carbon-dioxide. Later knowledge has shown that this is not so. If a room is ventilated with air containing a higher dose of carbon-dioxide, still there is no oppressive feeling. It is the increase of humidity of the room due to exhaled water vapour and the rise of temperature of the confined air that give rise to the feeling of oppression. The remedy

lies in the cooling down of the temperature and the removal of humidity. This is brought about by ventilation.

The Table below gives the cubic feet of carbon-dioxide exhaled by cows per hour and the requirement of air, and also of the cubic feet of space.

TABLE-54

Animal.	Cubic feet carbon-dioxide exhaled per hour.	Cubic feet of air required to keep carbon-dioxide below '09%	Cubic feet of space required per head for keeping CO ₂ within '08%
Large cow	6	10,000	1,100
Medium cow			
or horse	3	5,000	550
Man	0·6	1,000	330

When cattle are kept in closed sheds there should be ample opening at floor level and near the ceilings to allow unobstructed ingress and egress of air.

764. Balanced ration : After having gone through the nutritional requirements of carbohydrates, proteins, minerals and the vitamins, we are now in a position to construct a balanced ration for the herd. Balanced ration is one which furnishes the several nutrients : proteins, carbohydrates, fats and minerals in such proportion and amount as will properly nourish an animal for 24 hours.

The requirements for the maintenance of an animal depend upon its live-weight which is found from schedule or formula (925) or by actual weighing.

Of the total requirements, the needs for proteins and starch equivalents have been indicated. (730-'32)

765. Nutrition and live-weight : It has been mentioned that nutritional requirements vary not proportionately to live-weights of animals but proportionately to two-third power or to $\cdot 73$ or $\cdot 78$ power of weights. A Table made out on that basis shows the differing requirements for various weights to be as under :

Weights	500	600	700	800	900	1,000 lbs.
Digestible						
proteins.	0.338	0.399	0.458	0.516	0.570	0.625 lb.

If 0.338 lb. protein is required for a 500 lbs. live-weight, then for an animal of 1,000 lbs. live-weight, the proportionate requirement would be double of 0.338 or 0.676 lb. The calculation on the basis of 2 power of the weight shows the tabled figure to be 0.625. This difference between proportionate figures and those from power calculations do not much matter, considering the widely uncertain requirements which we have to deal with. Proteins are different ; mineral requirements also are governed by many known and unknown factors. With so many inexact points, the difference between the tabled mathematically exact weights and the proportional weights should be regarded for practical day-to-day work as immaterial. If, therefore, the requirements for a 500 lbs. live-weight be tabled, the reader will be able to find the requirements for other living-weights proportionately.

766. Maintenance ration for a 500 lbs. grown-up cow at rest :

TABLE—55

Dry matter lbs.	Digestible protein. lb.	Total digestible nutrient. lbs.	S.E. lbs.	N. R. nutrition ratio.	Not to exceed.		
					CaO gram.	P ₂ O ₅ gram.	K ₂ O gram.
10-12½	0.34	4	3.05	10.8	24	15	70
							24

The above Table gives the maintenance-requirement for cattle at rest. This is a laboratory condition. As a matter of fact, all animals, even when at rest, do move about and, therefore, do some work. Grazing involves work. An animal that has to walk miles for grazing does the work of walking that distance and, therefore, extra ration has to be allowed for the work involved. Maintenance ration is a theoretical constant, to which is to be added nutrition for the work to be done. This work may be grazing, may be carting or ploughing or carrying a calf or milking. These work-requirements are shown separately for adding on to the maintenance-requirement.

A distinction is also to be made between a grown-up cow and a growing cow. A growing cow has to put in about a pound weight of increment per day. Therefore, growing animals require nutrition on a different basis.

In this example, a nutrition ratio of 10·8 works out with the ·34 digestible protein and (8·05—·84) digestible nutrients provided for. But if, as a matter of fact, a fodder is chosen within the range of dry matter and protein requirement, but if the Total Digestible Nutrients (T. D. N.) be more than what is in the schedule, then the nutrition ratio will be altered. The widening of the nutritive ratio in this event will not be harmful to a certain extent.

About the requirement of Potassium it is to be understood that the amount indicated should not be exceeded.

In this Table only a 500 lbs. live-weight has been indicated. The maintenance requirements for other weights may be worked out proportionately to this weight.

767. Requirements for growing cows : The next Table (Table 56, Page 741) indicates the requirements for growing cattle. During the period of growth of an animal, it has to be provided with such nutrients that it can add on daily one pound to its weight for the larger breed cattle of 700 to 1,000 lbs. weight. This period of growth is the most critical period in the life of the cattle. If they are not allowed to develop as they should, then their future is blasted. After a stunted growth during the period of development, an animal may be fed and well cared for afterwards. They may make up weight and look healthy, but they will not be able to perform the functions required from full-grown animals of that particular type which had the necessary growth and development from the very

womb of the dam. If it be a female calf she is likely to be a bad milker, however much she may be fed, during gestation or when she is milking. After-care will certainly improve conditions, but serious neglect during the period of growth cannot be wholly made up.

While considering the nutrient, it was mentioned that the protein was the material for building flesh, skin, hair etc., and that calcium-phosphorus were bone-making materials. During the growing period flesh and bones grow, and it is very necessary that these building materials be fully supplied during growth.

It should be understood that there would be a large difference in the requirements of a 500 lbs. cow for maintenance, and for a 500 lbs. growing cow, heifer or bull, meaning those that are growing up to greater size. As has been said, this is computed at one pound per day increase in weight, and involves the expenditure of 2 to 3 lbs. of extra energy for the work of growing, and proportionately of other items of nutrition. (648)

768. For growing animals : Whereas for mere maintenance for a 500 lbs. animal 0.84 pound of protein is required, for a growing animal of the same weight, an animal that has expectation of more growth, the protein requirement is about $2\frac{1}{2}$ times, and starch equivalent is double. Indeed, the growing period is a costly period. No work is obtained, but the feeding costs of growing animals are not less than those of working or milking animals. (648)

TABLE—56

(See also Para 673)

Dry matter. lbs.	Digestible protein. lb.	Total digestible nutrition. lbs.	Starch equivalent. lbs.	Nutrition ratio.	CaO gram.	P ₂ O ₅ gram.
100— 1·5 to 2·5	0·32	1·5	1·8	4	42	30
200— 4·6— 5·6	0·55	3·5	3·3	5	50	35
300— 7·2— 8·0	0·70	5	4·5	6	60	45
400— 9 —10	0·85	6	5·3	6·3	70	50
500—10·5—12	0·93	7	6·1	7	75	55

769. Requirement for work: We know that for work it is starch equivalent which is wanted. Upon this supposition, by adding more digestible nutrients without proteins to the ration, we should have got what we wanted. As a matter of fact, however, more starch equivalent cannot be consumed by the animal without a share of proteins. (690, 692). For eight hours heavy work double the maintenance quota of protein and double the quota of starch equivalent would be necessary. These quantities cannot come out of the roughages, for the total dry matter up to the capacity of the animal may have been put in for

providing maintenance requirements alone. If that is so, the extra requirements have to come solely from concentrates. If there was left a margin on the maintenance requirement then that margin of roughage will, of course, be fed to go towards meeting the extra requirement, supplemented by protein and digestible nutrients to make up the total. For less than 8 hours work less would be proportionately necessary. (672)

770. Additional requirements for milking : For feeding milch cows the maintenance requirements have to be met liberally as provided for in Table No. 55. For every pound of cow-milk, containing 4.5 to 5 per cent fat, the following is delivered in the milk by the cow :

TABLE-57

Nutrients voided by cow per pound of milk

Digestible protein	Total digestible nutrient	Starch equivalent	CaO	P ₂ O ₅
lb.	lb.	lb.	gram.	gram.
0.05	0.35	0.30	0.5	0.4

Additional feed is based upon the milk-contents of the nutrients. Milk contains the following :

Protein	...	3.3 per cent
Total digestible nutrients.	16.2	„
Calcium	...	0.12 „
Phosphorus	...	0.09 „

With every pound of milk the above percentages of the nutrients come out of the cow. This has to be

replenished, allowing for the lossage in metabolism and also in quality.

Protein requirement in the feed is calculated variously on the milk-content at 1·6 times to 1·25 times the weight of protein present in the milk. Taking 1·6 times the contents of the protein in milk to be necessary to be put into the feed for satisfying the requirement, the amount of protein necessary in the feed comes to $\cdot033 \times 1\cdot6 = \cdot05$ lb. This figure is accepted.

Digestible nutrient : 100 lbs. of milk contains 16 lbs. total digestible nutrient, including fat. For one pound, $\cdot16$ lb. of T. D. N comes out of the cow. If twice this is put in the feed the total digestible nutrient comes to $\cdot32$ lb. which will correspond nearly to $\cdot30$ lb. of starch equivalent.

Calcium and phosphorus : If the milk contents of these are calculated, and 1·5 times put in the feed, the figures come to $\cdot5$ gram for CaO and $\cdot4$ gram for phosphorus. (672)

771. Requirements per pound of milk : The figures for requirements are tabled.

TABLE—58

Digestible protein lb.	Total digestible nutrients. lb.	Starch equivalent. lb.	CaO gram.	P ₂ O ₅ gram.
0·05	0·32	0·30	0·5	0·4

The matter of requirements for milk production is considered again in connection with dairying.

CHAPTER XX

NUTRITIONAL DEFICIENCIES AND THEIR CORRECTION

772. Balanced requirement is true requirement :
So far we have studied the requirements of various nutritional elements for maintenance and work. This has been an one-sided affair, because individual items of nutrition do not act as single units, but together they form a composite whole. It would not do to lose sight of the fact that the nutritional necessity of an animal-body for any particular purpose of any particular item requires the simultaneous presence of all other items of nutrients. An animal may require a certain amount of protein daily, but if only its requirement of protein is met, still it will not be able to secure protein equilibrium unless all other nutritional factors are present at least in their minimum. This fact is often lost sight of even in scientific experiments on digestibility-trials etc. If, along with the meeting of the protein-requirement, the energy, the mineral and the vitamin requirements are fully met, then only can the protein-supply be used to the best advantage, and the ration will be a balanced ration. Diets may be unbalanced by including in it excessive quantities of one or other of the ingredients, and it is stated that even an excess of vitamin D, contained in sun-dried hays, may upset

the balance and turn an otherwise balanced ration into an unbalanced one.

In India, a very large percentage of the cattle have been suffering from mal-nutrition of a severe type. This is due to insufficient food being given which even quantitatively lacks the essentials. Less protein is fed and less starch equivalent is fed than is necessary to maintain them, not to speak of obtaining work or production out of them. This mal-nutrition is immediately and most remarkably reflected in sterility, either of a temporary or of a permanent nature.

773. Sterility from mal-nutrition : Sterility makes animals unremunerative, and the longer the sterility continues in an animal, the more is it neglected by the owner and the deterioration proceeds yet faster. Deficiency in any one of the several nutritional requirements is likely to make an animal sterile. Unfortunately not in one but in almost all the items in protein, in total digestible nutrients, in minerals, and occasionally in the vitamins too, there are deficiencies. Mr. Leitch of the Imperial Bureau of Animal Nutrition, Aberdeen, observed :

“Fertility depends, in the first place, on the simple quantitative adequacy of the diet. Famine and war sterility or diminished fertility, is known in all classes of farm animals and in human beings. Following the Great War sterility was common in cattle, goats and sheep in Germany and Hungary...”

In addition to general under-nutrition, deficiency in minerals have been known to cause sterility.

774. Sterility and phosphorus deficiency : He continued :

“Naturally-occurring deficiencies of mineral elements have been shown to affect fertility. Of these, possibly the most important is deficiency of phosphorus since it is of wide-spread occurrence in natural pastures throughout the world. It has been shown by Theiler and his associates in South Africa, by Henry in Australia, and by Eckles, Becker and Palmer and Hart in the United States, that deficiency of phosphorus results in abortions and sterility. In observations on 200 native scrub cows, half of which received a supplement of bone-meal, Theiler, Green and Du Toit found that 80 per cent of the bone-meal-lot calved normally, while only 51 per cent of the controls calved. Du Toit and Bisschop report an experiment continued for three years with 109 bone-meal-fed cows and 20 controls in which the bone-meal-fed group produced 87·3 per cent of the possible number of calves, while the control group produced only 56·5 per cent of the possible number. Eckles, Becker and Palmer also found that feeding a phosphate-supplement improved fertility. They attributed the low fertility associated with phosphorus deficiency to infrequency of ovulation. ...”

775. Sterility and calcium deficiency : “In experiments in which dairy cows were fed greatly restricted rations, confined practically to a single fodder-plant, oat, wheat or maize, Hart and his co-workers showed that addition of calcium was

essential to secure reproduction. . . . Hart also records that cows fed on hay and straw grown on acid soil and containing less than the normal percentage of calcium, were unable to produce normal healthy calves. In an experiment using a ration of low calcium-content, Meigs found that cows were very difficult to get in calf, while controls with a supplement of calcium carbonate gave much better results. . . .”

776. Deficiency and infection : “In addition to this direct influence of diet on fertility, there is the other, possibly even more interesting and important, indirect effect through its modifying action on susceptibility to infections. It is known that malnutrition practically determines susceptibility to certain infections, and there is evidence that it may be an important pre-disposing factor to infection with *Br. abortus* and other organisms which interfere with reproduction. . . .” (*Indian Journal of Veterinary Science & Animal Husbandry*. 1933 —P. 198)

ABORTION FOR MINERAL DEFICIENCY :

A case is reported from Madras which conclusively proved how mineral deficiency caused abortion. (*Indian Journal of Veterinary Science & Animal Husbandry*. 1939—P. 415).

In Madras in an army Stud Farm there were outbreaks of equine abortion. Prior to 1929, there were about 7 abortions on the average every year. It so happened that in 1929 the authorities in their attempt to improve the skeletal frame of the foals, introduced

mineral feed, containing calcium. After this feed was introduced abortion stopped. The new mineral-feed was expected to give better bones, but this was not found to be the case and was, therefore, stopped in 1934. Abortion re-appeared in 1935 with 2 cases and reached 12 cases in 1936. At this time expert advice was taken and it was discovered that it was calcium that was wanting in the feed. Accidental use of extra calcium had stopped abortion, which re-started with the discontinuance of the mineral feed. Extra calcium feed was re-introduced, and with it abortion disappeared.

777. Mal-nutrition deficiency and reproduction : Crowther observed that until recent years reproductive troubles were commonly sought for in the field of disease, but conclusive evidence is now available that in very many cases the basic causative factor was faulty nutrition. Under-nutrition includes general deficiency of energy-supply or deficiency of one or more of the specific essential factors such as vitamins or minerals. These deficiencies lead to disturbance of oestrus cycle and then to actual cessation. Crowther was positive that maternal diet must include extra amounts of vitamin A and E which can be had from green leafy feed.

778. Calcium deficiency and reproduction : Dr. Sen (*Agriculture & Live-stock in India*, November, 1933.) observes that mal-nutrition, especially deficiency of lime or phosphorus or both in the ration, may lead to either sterility or abortion in the female. Sometimes, there may be no abortion, but the calf may be weak and may not survive long. Lime-deficiency

usually occurs in stall-fed animals which are given concentrates, and these concentrates lack in lime. Lime-deficiency also occurs where no grazing can be obtained and a better type of fodder is not available. One of the commonest symptoms of this lime-deficiency is the tendency of animals to eat earth and mud. Dr. Sen opines that all young animals have a great craving for minerals owing to their high requirement for bone-formation.

779. Dr. Sen on deficiency : *Phosphorus deficiency and sterility* : According to Dr. K. C. Sen, another mineral which affects the fertility of domestic animals is phosphorus. Pastures in many parts are highly deficient in phosphorus, and the cattle develop a condition peculiar to the deficiency of phosphorus called a-phosphorosis. They get emaciated, develop depraved appetite such as chewing of bones, and carcass or refuse matters, become prone to infective diseases and get partially or completely sterile. The addition of phosphorus-rich substances, Dr. Sen observes, such as bone-meal (which contains lime as well) improves their condition.

The evil effects of phosphorus-deficiency are markedly prominent in India, because the natural pastures of India are highly deficient in phosphorus.

Dr. Sen in another article in "Agriculture & Livestock in India", March, 1935, followed up the subject and mentioned that lack of lime or phosphorus or both lead to emaciation, pica (depraved hunger) unthriftiness, stunted growth, sterility, low milk-production or bone diseases in cattle. He observed :

"...Our observations show that under laboratory conditions, the effect is much more pronounced in imported or half-bred cattle than in indigenous animals, though even in the latter the ill-effects of a low mineral diet are always observable. ..."

780. **Experiment on the cow—Khairi :** "Examples of this nature are shown. Fig. 43 is the photograph

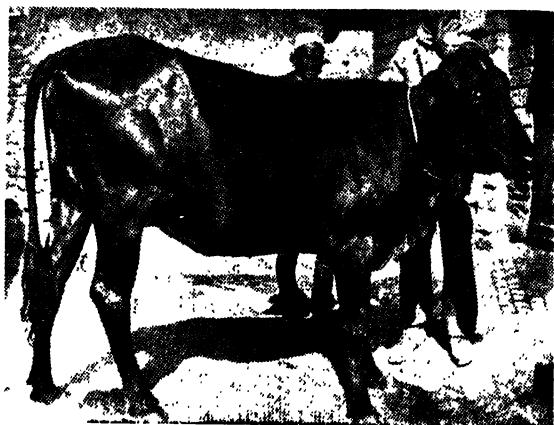


Fig. 43. Khairi 75, Holstein-Hariana, on normal dairy ration.

(Agriculture & Live-stock in India., Vol. V, Part II)

of one of our dairy cows, Khairi 75, a half-bred Holstein-Hariana. She was a good milker, had already passed three lactations, and was in calf when she was brought under the present experiment, where she was put on a phosphorus-deficient diet, or more correctly, on a diet which had an abnormal lime phosphorus ratio, with a slight

protein-deficiency for the first two months. Within a few months of the experiment the animal had lost much weight and, gave birth to a calf which died in an hour's time. Fig. 44 was taken at this time, and the condition of the dam and calf is readily seen. A highly unbalanced ration with a low amount of phosphorus and a slight deficiency



Fig. 44. Khairi 75, with her dead calf. Note the extremely emaciated condition. Diet very low in phosphorus, rich in lime and slightly deficient in protein.

(Agriculture & Live-stock in India., Vol. V, Part II)

of protein in the diet, in fact, led to a marked emaciation and the birth of a non-viable calf. The condition of the animal became so bad after calving that she had to be returned to the normal

dairy ration but did not improve for about a month ; and it was only when in addition to dairy ration, she was allowed to graze on a very good pasture land, containing plenty of green grass, that she rapidly regained her original weight."

In the above passage the importance of phosphorus sufficiency is well brought by the disaster that followed on giving full dairy ration which was deficient in phosphorus and slightly deficient in protein.

The fact should be noted also that *Khairi*, the cow of the experiment, did not get her condition back, even when kept on full and balanced dairy ration, till she was allowed to graze also. There was something in pasture grass which stall-feeding could not give. What is that mysterious thing in growing grass, that works like magic on starving and emaciated cows? This is beginning to be understood (868-'70) and is dealt with in connection with pasture grasses.

In continuation of the case of the cow *Khairi*, Dr. Sen observed that similar though not so striking results were obtained in trials with a Sahiwal cow—Hansi 207. Hansi was put on a diet poor in lime and rich in phosphorus, with a sufficient amount of protein. The animal started to lose condition gradually, became unthrifty, and died after about 5 months.

781. *Khairi's* trouble due to phosphorus deficiency : In connection with the experiment on *Khairi*, the Holstein-Haryana cow, Dr. Sen observed that another cow was fed the same diet as *Khairi*, but she was given in addition a phosphate supplement. She maintained her condition well, showing that the

misfortune that came to Khairi was wholly due to phosphorus-deficiency.

782. Knowledge of nutritional experiments :

Dr. Sen commented :

“The above results of laboratory experiments are so striking that it is necessary to consider if similar instances are to be observed under field conditions. It is well-known that in many parts of the country, the soil is poor in lime or phosphorus or both, and that this poverty of the soil is liable to be reflected in the composition of the pasture. In animals reared on such poor pasture, troubles due to mal-nutrition are to be expected, and the existence of various diseases due to deficiency of lime or phosphorus in the feed are well-known in various parts of Europe, America and South Africa, where most of the significant work has been done. Literature in this country is very poor on this subject due not to the non-existence of the ill effects of mal-nutrition, but rather to the fact that few have tried to study the subject, or when cases have come to their notice, have not placed their observations on record. It is well-known that deficiency of lime or phosphorus leads to certain types of bone-disease, and we have received reports of several such cases from South India recently. Equine osteoporosis, due to lack of lime in the diet, has long been known to occur quite frequently, and we have had cases of osteomalacia in cattle in a village the fodder of which, on analysis, was found to be low in lime and very poor in

phosphorus. Movement of the affected animals to an adjoining village where better pasture was available, stopped the progress of the disease. . . .”

783. Vitamin deficiency : “Considerable evidence has been brought forward in the last few years by American and South African workers that vitamin A deficiency in the ration of cattle may give rise to serious difficulties. In my previous paper a mention was made of the occurrence of ‘blindness in calves’ and abortion in cattle in some parts of India. It has been reported recently by South African workers that when heifers were kept on deficient diet, almost all of them gave birth to weak and blind calves, and the cause has been tentatively assumed to be due to vitamin A deficiency in the ration. . . .”

In the Bulletin of the I. C. A. R. No. 25, on ‘The Nutritive Values of Indian Cattle Foods (1938)’, Dr. Sen observed as under :

“Straw and hay, as commonly available in India, are practically void of vitamin potency. This is also the case with most of the concentrates. For this reason *a-vitaminosis-A* in a mild form is widely prevalent and occasional instances of this trouble, such as intra-uterine blindness, ophthalmia, in growing animals, abortion and sterility are found in many places. The only practical method of remedying this defect in the ration is to provide for green grazing, failing which, a suitable supplement of green feed, 8-10 lbs. daily, should be given to growing, in-calf and lactating animals.”

784. Vitamin deficiency in a Jail dairy : I was put in charge of the dairy of the Alipur Central Jail, when I was in the Jail as a prisoner in 1942-'44. My experience there corroborates the observations of Dr. Sen regarding *a-vitaminosis*. In the Jail dairy, some body put it into the head of the authorities that green grass was not safe for the dairy animals. A very promising bull died there of pneumonia. On autopsy a ladies hair pin was found embedded in the lungs, having penetrated there through its stomach. After that grazing had been stopped. The herd was kept solely on rice-straw, and a scheduled quantity of concentrates.

The dairy was an old place with me. I had served my previous term (1930-'33) in this Jail, and did all that I could for the dairy then. I caused Guinea grass to be planted all along the walks by the wall surrounding the Jail compound. On taking charge again in 1942, I was struck with the poor condition of the cattle. The familiar herd had changed beyond recognition. The grasses on the Jail compound were cut and thrown away. These changes led me to think. Last time the milk yield had risen to 2 mds. This time I found that barely 25 seers of milk were being obtained daily. On searching the records I found that out of the last 24 births there were 19 cases of calves found dead at birth or calves that lived only for a few days. Then, there were two blind calves living. At first the blame was laid on an old bull which had served too long to be really useful. But, in a few days it dawned on me that it was

vitamin-deficiency that did the mischief, when I found that no green things were allowed to the herd. The herd lived entirely on rice-straw and concentrates.

Provision for feeding green grass and also for exercise was made, and bone-meal was added to rectify the mineral deficiency of rice-straw. The death of calves at birth disappeared from the dairy the moment I took charge. In a few days of my arrival a calf was born. With special treatment it lived on. The calving followed at the rate of two calves per month, without any accident. During this term there was an out-break of an epidemic of black quarter which carried away six young calves. Despite this misfortune, the milk yield of the dairy shot up by degrees from 24 seers a day to a maund and a half, and remained at that rate for six months when I got my discharge. I have touched on the problem of vitamin supply and of the provision of bone-meal only. It would be incorrect to suppose that these were the only or even the main items for reforming the dairy. Many things were undone, in order to bring the dairy to an ideal condition within the cramping limits of Jail administration.

Experiments here proved to me how quickly a run-down herd may be brought to a fine form. At the time of leaving I had the satisfaction of feeling that the dairy was again in a first class condition, a condition in which I had left it 10 years ago in 1933. The dairy was the very breath of my life for the period that I was in the Jail.

785. **Famine and vitamin A deficiency :** For three years prior to 1939 there was very little monsoon in Marwar. But 1939 was an year of complete failure. This brought in famine. Food and concentrates could be brought from distant places to alleviate the suffering. But it was otherwise with roughages, particularly with green feeds. Vitamin A has to be obtained from green fodder and there is no green fodder. Vitamin-starvation naturally occurs. This happened in 1939 in Marwar. In 1936 green feed was available for only two to three months in place of the usual five months of normal years. In 1937 green feed for cattle was available barely for two months ; in 1938 there was practically no green fodder ; while in 1939 there was not a blade of grass to be seen to feed the cattle. The previous three years of *a-vitaminosis* had worked considerable injury on the cattle. Their reserve of vitamin must have been long spent up. In 1939, in spite of the full ration of concentrates and dry fodder to the cattle in the Cattle-Breeding Research Station at Jodhpur, the animals fell ill and 45 of them became blind in this institution alone, while animals suffered undescribable distress in many other places of Ajmere.

Want of vitamin A not only affected the eyes but in some cases attacked the salivary glands also, causing profuse salivation. There was general debility added to difficulty in moving the hind legs. Abortions were there as would be expected ; and those that calved gave birth to calves which were so under-nourished that they either died immediately

or survived a day or two. Calving mothers also died. Following the use of cod-liver oil for supplying vitamin A, some cows showed improvement and gave birth to calves. Nine pregnant cows after the cod-liver oil treatment gave birth to calves which were entirely blind (Fernandes.—*Indian Farming*. December, 1940).

786. Contagious disease and deficiency : Dr. Sen in his paper referred to above wrote :

“There is now a considerable amount of evidence to show that natural immunity to contagious diseases is dependent on the nutritional state of the body, and that diet has a definite effect on the increased resistance and decreased susceptibility of an animal towards an invasion by certain types of micro-organism, but as yet we do not understand fully the relation between diet and the incidence of infection. The experience of different groups of investigators, however, shows that any improvement in the quality of the ration by the incorporation of materials, deficient in natural food-stuffs, markedly increases resistance. Thus the South African workers found that the addition of phosphates to the phosphorus-deficient feed of cattle resulted in a decreased rate of mortality. Aberdeen workers have found that when the pasture was good, the natural anti-body response was greater than when the ration was un-balanced. An important observation has been made at the Nutrition Institute, Coonoor, that animals living on imperfect diets show a greater tendency to the infections of the respiratory and gastro-intestinal

tract, and that there is a tendency of stone-formation in the bladder. And the Aberdeen workers have found that the parasitic flora of the intestine is increased when animals are kept on a deficient ration. In the case of our half-starved indigenous cattle of low productive capacity, this disease-susceptibility does not often attract our attention, but striking after-effects of mal-nutrition are seen in the case of imported breeds or indigenous animals of good breed and high milk-yield..... The deficiency of vitamins and mineral matter in the locally available food-stuffs, raised on poor soil, has resulted in the partial mal-nutrition of the animals and has been one of the predominating causes of weakened resistance to disease. It should be realised by every nutrition worker that there is a 'threshold' value for adequate nutrition, and that there may be a veiled mal-nutrition indicated only by a falling short of full development and by a latent weakening of resistance to infection and exposure."

787. Calcium-deficiency and milch cow : "It is now widely accepted that a great loss of body-calcium is a predisposing factor in the greater incidence of certain diseases in heavy milking cows, such as milk fever, tuberculosis and Johne's disease."

788. Calci-phos. deficiency : J. B. Orr, Director Rowen Institute, in a paper discussed at the Veterinary Congress, 1929, mentioned that of the non-energy-yielding constituents, those required in the largest amounts are calcium and phosphorus.

They not only form the main elements in the skeletal structures, but are present as essential components of every living cell. Dr. Orr, after giving the minimum requirements of calcium and phosphorus, mentioned that the ration must obviously contain more than these minimum amounts, for only a portion of what is present in a ration is absorbed from the intestine.

789. Calcium assimilation : In Dr. Orr's opinion the absorption of calcium presents more difficulty than that of phosphorus. There may be an abundant supply of calcium in the food, while through difficulty of assimilation, the tissues may be short of lime. The amount absorbed in the intestine may vary from 0 to 80 per cent or more of the amount ingested. Therefore, factors affecting assimilation are as important as the amount present in the ration.

Dr. Orr mentioned that vitamin A and ultra-violet rays considerably help the assimilation of calcium. The vitamin was given in the form of cod-liver oil to young pigs on a ration of maize, etc., and the following results were obtained :

TABLE—59

Days	CaO intake gram	Balance CaO. gram	CaO retained in percentage of intake
1-7	3.48	+0.64	+18
8-13	3.48	+0.17	+5
14-19	3.48	-0.36	-10
20-22	3.48	-0.38	-14
Cod-liver oil given—			
23-28	2.32	+0.17	+7
29-34	2.32	+1.54	+66
35-40	1.7	+1.16	+68

The above figures amply show that the mere presence of calcium in the ration is nothing, and that its absorption is everything. With the feeding of 3.48 grams of CaO there was absorption of .64 to .17 gram, which then became negative as the days passed on, on the same ration. When, however, cod-liver oil was added, even from so small a dose of ingestion as 1.7 gram, 1.16 grams was retained. It shows what an important part vitamin A plays in calcium assimilation. Ultra-violet rays administered in the laboratory experiment showed similar results—absorption going up from .46 gram to 2.10 grams after 22 days of light-ray exposure.

The nature of diet reflects similar alteration, a higher proportion of calcium is absorbed from fresh pastures than from most other food-stuffs.

The ratio of calcium to phosphorus affects the balance, a large excess of one affecting the absorption of the other.

790. Deficiency and growth : Theiler's figures for cattle go to show that the feeding of bone-meal to the stock, grazing on a phosphorus-deficient pasture, resulted in a rate of growth three times greater than that of control animals without bone-meal on the same phosphorus-deficient diet. The phosphorus deficiency had obviously restricted the rate of growth to a third of the animal's capacity. A similar result was obtained by feeding bone-meal, when the milk yield increased by about 40 per cent.

Deficiency very strikingly affects the health of animals. The metabolism of calcium is closely linked

with that of phosphorus, especially in the bones. With deficiency the animal becomes unthrifty, gets a staring coat, and has a tendency to emaciation, lethargy and stilted gait. Accompanying these symptoms there is depraved appetite. The abnormal substance eaten is usually rich in the material which was deficient in the food.

South African workers also confirmed the fact that calves from cows on phosphorus-deficient pastures were lighter at birth and weaker than those of control animals receiving bone-meal. There is a general constitutional disturbance due to mineral-deficiency, and only some pathological changes get manifested. These are accompanied by disturbances of the functions of the ductless glands.

It has been the common experience in South Africa that the feeding of bone-meal and salt to cattle of a phosphorus-deficient area was marked by a decrease in death-rate in bone-meal-fed groups as compared with the controls. In India some workers have found that mal-nutrition makes the animals very much more susceptible to attacks of parasites.

791. Making up the deficiency : The making up of the deficiencies in ration is, however, easy. When there is a deficiency of protein and total digestible nutrients, they have got to be supplied. When there is a deficiency of non-energy producing mineral elements, the remedy lies in feeding what is lacking.

Proteins can be supplied from oil-cakes and leguminous grasses and pulses. Energy requisites are

well supplied by cereals. Calcium-deficiency can be met from bone-meal and also from oil-cakes. A few anti-deficiency feeding-materials stand out prominently and their utilisation may easily change an unbalanced ration to a balanced one.

(1) Green grass for vitamin A-deficiency, and for correction of many imbalances. This is best ingested when the animals graze on pastures.

(2) Oil-cake for protein and phosphorus deficiency.

(3) Legumes, pulses and hays for protein and calcium-deficiency. Bone-meal is also slightly contributory to proteins.

(4) Common salt for making up salt-deficiency. Almost all feeds needed salt. Common salt is needed to correct the excess of potassium ingestion also. A very large number of feeds require bone-meal also.

These few easily-available materials are to be looked for to correct the imbalance.

CHAPTER XXI

SOME FODDERS AND FEEDING MATERIALS AND THEIR COMPOSITION

792. **The cereal straws :** Straws are bad for fodder. As we shall presently see they contain very little protein and a small amount of phosphorus which is in some instances of doubtful quality. On the other hand, they contain a very large amount of potassium which exercises a harmful influence in more than one way, and hampers the assimilation of what little nutritious matters are present. For this reason, straws are regarded as poor roughages, supplying only a portion of energy, and mainly meeting the purpose of filling the belly.

In cattle-breeding, therefore, nutrition is sought for from other quarters than from the straws of cereal grains. For better cattle-breeding, the growing of fodder-crop is necessary ; and in other lands they grow fodder-crops of suitable character to serve as the main feed. These fodder-crops may yield grains but the grains are either not allowed to develop when the fodder is cropped, or if the grains are allowed to mature, they also are fed to the cattle as concentrates, so that whole fodder plants, seeds or grains and stalks and leaves and all go to make up the feed. Cereal

straws are considered fit for use as litter only in Europe and America.

In India we are in a different position. Very little acreage is under fodder-crop, and the cattle population has to depend mainly upon the straws of food-grains.

The best portions of the plant are represented in the grains, and the grains are taken away for human food. What is left is unable to maintain the life of the cow. Yet, dependence upon such poor stuff has been the lot of the cows of India to a large extent ; and such is the misfortune that even this poor quality non-nutritious feed is not available to the required extent, being short, as the statisticians say, by 45 per cent.

793. The importance of cereal straws : Therefore, cereal-straws, poor as they are, will continue to be fed. We shall take a few of the more important of the cereal-straws and try to learn about their utility and deficiencies so that when used, their deficiencies might be corrected. Rice, wheat, *joar*, *bajra*, *ragi*, and oats are dealt with, which will give a general picture and help us in estimating the value of other cereal-straws not described, but listed in the digestibility Table of fodders. The digestible constituents and minerals of these are given in the Para 729.

794. Rice-straw : Rice-straw is an important fodder. It has been found that rice areas are areas of large production, having heavy rain-fall as compared with other areas where the rain-fall is scarce and, therefore, the productivity of the soil is less. These areas of productivity are exactly those areas where the cattle are poor. This had been regarded as a fact,

but a mysterious fact, defying explanation. (397, 505, 655, 814, 826)

795. Better animals from dry areas : Dr. K. C. Sen who is in charge of the Nutrition section, Imperial Veterinary Institute, Izatnagar, wrote :

“...A very curious fact is that most of the good animals in India come from the tracts where rainfall is low and water is scarcely available. With the increase in the irrigated areas, and consequent increase of crop-production, grazing areas are getting fewer, and animals coming from irrigated tracts are much inferior in condition so far as their performance is concerned, and, moreover, these animals are more susceptible to parasitic infections and disease in general. This observation is of the highest importance to agriculturist and animal-husbandmen alike, and attempts should be made to find out if this difference in disease-susceptibility and in performance is due to climatic considerations, to nutritional differences or to any other causes. The Punjab experiments, however, have shown how much it is possible to improve the local breeds by selective breeding and judicious feeding, and experiments made in Pusa support the idea, that good animals can be raised from almost any breed of animals available in India, provided the degeneration has not proceeded too far.” (*Agriculture & Live-stock in India. November, 1933*). (397, 505, 655)

796. Best cattle bred in drier districts : Sir Arthur Olver published a paper in “*Agriculture &*

Live-stock in India" in September, 1938, prior to his retirement, in order to place on record the conclusions which he had formed after 8 years of close study of the problems of live-stock in India. In this paper, as also previously on several other occasions, he brought out the fact of there being inferior cattle in wet areas. He wrote :

"As a general rule, it can be taken that throughout India, the best cattle are bred in the drier tracts where free grazing is scanty and the grass grown is not coarse, and this fact may be taken as a sure indication that the coarse grass produced in forest areas, under heavy rain-fall conditions, is not sufficiently nutritious to produce good stock. In wet areas it is unlikely, therefore, that much improvement can be effected by the mere introduction of stock, accustomed to drier conditions and more highly nutritious food-stuffs. The policy, therefore, should be to improve the local breeds by careful selection and systematic animal husbandry work, designed particularly to provide better fodder and to control parasites which, in such areas, are nearly always a serious cause of degeneracy and ill-health.

"In the rice-tracts the degeneration of cattle which occurs, appears to be largely due to the fact that the people are not cattle-minded and take no steps to provide nutritious and health-giving fodder or semi-fodder-crops such as the legumes and grasses or *joar*, *kadbi* which are extensively grown by cattle-breeders in districts where the best stock

are bred and reared. It seems, however, that crops of this kind could usually be produced in rice tracts if suitable seeds were thrown in on the last watering of the paddy-fields." (397, 505, 655)

797. **Causes of inferiority in wet areas:** Whatever be the reason, the fact stands that the cattle areas of heavy rain-fall or what is the same thing, the cattle of rice tracts are very poor and degenerate. Both Dr. Sen and Sir Arthur Olver seem to think that factors are at work which have not been fully explored. Dr. Sen seemed to be inquisitive and would have liked to find out the root cause of degeneracy of the cattle of the wet areas, whether this was due to climatic, nutritional or other causes. The latter seemed to attribute the degeneracy to the absence of cattle-mindedness in the people of these tracts, for, in his opinion, they could improve their cattle if they could grow fodder which they could easily do.

The real cause is that the main fodder of rice-areas is rice-straw which is a very deficient material (798-'800) as regards nutrition; so also is rice-bran or *kura*. (397, 505, 655)

798. **Importance of rice area:** But we cannot pass over this question with simply mentioning this fact. The rice-area is an important area, and improvement or deterioration of cattle in these areas will mean and does mean corresponding change in the fate and fortune of the millions of people inhabiting these areas. The importance of rice-areas is great in India, and the cattle problem of these areas and consequently the main cattle-fodder of these areas,

rice-straw, deserves more than a passing notice. The area under rice in the various rice-tracts will enable us to understand the significance of the problem.

Provinces.	Portion under rice.
Kashmere, Sind, Madras and Central Provinces	over 20 %
Bihar . . .	over 40 %
Orissa . . .	over 60 %
Bengal . . .	over 80 %

The above is the roughest division of rice areas in India.—(I.C.A.R., Bulletin No. 38). (397, 505, 655)

799. Area under rice and other grains : There are 69·5 million acres under rice out of 186·7 million acres under foodgrains (Rice, Wheat, Barley, Joar, Maize, Gram and other food-grains and pulses), forming 37 per cent of the total area under food-crops. These 69·5 million acres are roughly distributed as under :

Area under rice in British India.

Bengal	...	22·2 (million acres)
Madras	...	10·1 ,,
Bihar	...	9·5 ,,
U. P.	...	7·1 ,,
C. P., Berar	...	5·8 ,,
Orissa	...	5·1 ,,
Assam	...	5·0 ,,
Bombay	...	2·3 ,,
Sind	...	1·2 ,,
Punjab	...	1·1 ,,
Miscellaneous	...	0·1 ,,
Total—		69·5 ,,

The total area all over India under rice is, however, 72 million acres being 25 per cent of the total area sown. (397, 505, 655)

800. Unbalanced rice-straw feed responsible for degeneracy: There is, however, no doubt that mal-nutrition has been a determining factor in the process of slow deterioration, and that unbalanced feeding of rice-straw has largely contributed towards the present position. This should serve to clear away the mystery about the presence of inferior cattle in the rice-areas or areas of heavy rain-fall. It is really rice cultivation that has been the determining factor in particular areas. These rice-areas are, except Bengal or Assam and Orissa, to be found in certain special localities in the provinces, whose cattle stand in their inferiority as a contrast to those of other areas in the same province. It has been mentioned in connection with cattle-breeding in Madras, that whereas some of the finest milch and draught types belong to this province, there are also some of the poorest cattle there. There is a low-lying belt in the delta of the Krishna river. This belt falls within the rice-area and the cattle are very, very poor. In the Tanjore District in Madras there is another equally poor area. The case of Malabar has been mentioned (179) and also of Kashmere and the Kangra Valley where rice is grown. In all these areas the cattle are poor, and so are the men. The problem of rice-straw areas is a vast one, connected with the welfare of millions of cattle and men. (397, 505, 655)

801. Yoke efficiency of bullocks: The Royal Commission brought out the requirement of bullocks per 100 acres of sown area. In Bombay, one pair of bullocks cultivated 20 acres, whereas in Bengal one pair does only 5·5 acres. Mr. I. B. Chatterjee, researchist on nutrition at Bangalore, has calculated the yoke efficiency from the Royal Commission Report as under :

Bengal	...	1
U. P.	...	1·2
Bihar, Orissa	...	1·3
Punjab	...	2·3
Madras	...	2·3
C. P.	...	2·4
Bombay, Sind	...	3·6

The figures show that Bombay bullocks can do three and half times the work that the Bengal bullocks can do. This is an exception. The bullocks of the Punjab, Madras and C. P. do more than twice the work of Bengal bullocks, or for the matter of that, of the rice-area bullocks. Bengal is practically entirely a rice-area, and the performance of the bullocks is the same in all-rice areas, although divided into provinces. The bullocks of the Krishna delta area or of Malabar or of Orissa are as weak and stunted as those of Bengal. (397, 505, 655)

802. Total Nutrients of rice-straw. %

TABLE—60

	Crude protein	Fibre	N. F. Ext.	Eth. Ext.	CaO.	P ₂ O ₅	Na ₂ O	K ₂ O
Average	2.92	33.36	45.58	0.86	0.50	0.15	0.50	1.63
Aman Bengal	3.25	33.63	47.91	1.03	0.71	0.12	0.27	1.78
Aus Bengal	5.04	34.92	45.63	1.57	0.64	0.18	0.21	2.03

Digestible nutrients of rice-straw.

	Crude protein.	Total Dig. nutrients.	Nutritive Ratio.	Starch equivalent.
Bangalore	0.00	49.54	...	30.1
Aman Bengal	0.28	44.13	154.4	24.5
Aus Bengal	0.44	44.57	100.2	24.1
Bihar (Kanka)	0.00	50.23	...	32.2
Punjab (Kangra)	0.00	41.62	...	20.3

—(397, 505, 655)

803. **Nutrition from 10 lbs. of rice straw :** The digestible protein of rice-straw is nil in some cases and .28 to .44 in some others. Cows fed on rice-straw will get practically no proteins. The total digestible nutrients are, however, fair, ranging from 50 to 41, and the S. E. is 25 on the average. The mineral contents are, however, extraordinarily against balanced rationing. In lime (CaO) it is very poor. The samples showed ranges from .50 per cent or 2.2 grams per pound. In phosphorus it is poorer still, having .12 per cent in *aman* straw, equivalent to a content of .5 grams per pound of straw.

If 10 lbs. of straw are fed to a 500 lbs. cow, supposing the above analytical figures are correct, then that cow will have :

Rice straw ...	...	10 lbs.
Proteins, ...	...	nil
Digestible nutrients ...	...	5.0 lbs.
Starch equivalent ...	...	2.5 lbs.
CaO ...	...	22 grams.
P ₂ O ₅ ...	...	5 grams.
K ₂ O ...	...	80 grams.

Three matters come strikingly out of the above figures.* Rice-straw has no protein, is too poor in phosphorus, and is excessively loaded with potassium. The calcium-phosphorus ratio is also necessarily very unsatisfactory.

An outstanding disproportion in the calcium phosphorus ratio affects all other factors adversely.

An excess of potassium not only leads to the non-absorption of calcium but it also drives out sodium (Na_2O), and itself gets driven out. (397, 505, 655)

804. Rice-straw is never the only feed : Rice-straw is a difficult material to tackle. The cows have been living on this as their main ration for generations. No cow, however, can live entirely on such a stuff as dry rice-straw, and indeed, this is never used as the sole ration. The cows must have been ingesting some protein and some phosphorus and some salt from other sources, otherwise they would have been extinct. However, it is still a wonder that they continue at all to exist and procreate.

The only possible feed which a poor cultivator can add to rice-straw must be *Dub* grass. (866-876) With the increase of the cultivated area, pastures have become rarer, and today in thickly-populated areas there are practically no pastures. Sufficient supply of *Dub* grass from pastures could give life to the dead feed of rice-straw. With the shrinkage of this source, deterioration has been going on rapidly, and I do not think that we have reached the bottom of deterioration yet, in all the rice-tracts. For example, Bengal cattle in their deteriorated state of today are much superior to the deteriorated cattle of Orissa, another rice-growing province.

In Bengal mustard is grown and mustard oil is largely used, leaving mustard-cake for the cattle. The proteins of this goes to feed the cattle, to

the extent that this cake is supplied. Even as a concentrate mustard-cake is inferior to linseed or *til* cakes. This is the sum-total of the feed in the rice-tracts, particularly of Bengal.

The question is whether cattle can be fed rice-straw to better purpose with such combination as may come within the means of the cultivator. To determine this, rice-straw has been the subject of experimental feeding by the I. C. A. R. in Bengal. (397, 505, 655)

805. The Bengal experiments on rice-straw feed : The experiments began in Dacca and Krishnagore, and the first paper on the research was published in September, 1937 in the "Indian Journal of Veterinary Science & Animal Husbandry". The experiments were made by M. Carbery and Indu Bhusan Chatterjee. The paper is entitled "Studies in the Mineral Requirements of Cattle in N. E. India with Special Reference to Rice-straws." (397, 505, 655)

806. Papers on rice-straw feed experiments : Upon the materials dealt with in this paper several articles appeared in the "Agriculture & Live-stock in India" which are more or less culled from the above paper as under :

(1) July, 1938—"Preliminary Note on the Behaviour of Rice-Kura (Bran) as a Cattle Feed"—By Carbery & Chatterjee.

(2) July, 1938—"The Value of *Aus* Paddy Straw as Fodder"—Chatterjee & Hye.

(3) September, 1938—"Can Water-Hyacinth be Used as a Cattle Feed"—Chatterjee & Hye.

(4) September, 1938—"Lime and Phosphorus Requirement of Bengal Cattle"—by Chatterjee & Talapatra.

In the April, 1942, issue of "Indian Farming" Chatterjee discussed the position in a popular article—"Rice-straw ; Its Feeding Value and How to Improve It." In this article, the defects of rice-straw were set out. (397, 505, 655)

807. Defects of rice-straw : "The main defect of rice-straw is that it is very poor in protein and phosphorus and contains a large quantity of crude fibre on the one hand, and a substance which interferes with the proper absorption of lime, on the other. Again, depending on the nature of feed-combination and kind of straw, the digestibility of straw-protein varies from nil or even negative (i.e. more is excreted than is supplied through the straw) to 3, 4, 5 going up to 34 per cent. Thus in an experiment with winter or *Aman* variety of straw as an exclusive feed which was continued for a period of 111 to 150 days, the animals (starting live-weight were 375 to 403 lbs.) lost to the extent of 38 to 85 lbs., and the efficiency of general digestion was reduced by 25 per cent in the course of only two months, whereas in subsequent periods it became still worse. As an instance, the animal which was able to derive 5.3 lbs. total digestible nutrients during the first test could not draw more than 3.9 lbs. during the second test after an interval of two

months. ...In the case of another animal the result was still more disappointing..." (397, 505, 655)

808. Only negative results from feed experiment :

From the above the reader will have some idea of the experiments. Details of the experiments were published in the paper referred to. It is unfortunate that only negative results have been obtained. As a scientific study its value is diminished, because well-known nutritional facts were not taken into consideration during these experiments. For example, it is a first consideration in feeding experiment that vitamin A should be supplied with fodder to make the animal ingest what is needed. These series of experiments started with giving dry rice-straw only with the addition of a little salt. When no vitamin is supplied, the cow cannot take out the nutrients for absorption even from otherwise balanced diets. In the discussion on vitamin-deficiency it has been shown that foods, otherwise suitable, could not maintain the health of the cow—Khairi (780-'81), and that she could not regain her constitution even when normally stall-fed (which must have included green feed) after the experiment. It was only when she was allowed to graze in addition to receiving the normal stall-feeding that she recovered. (397, 505, 655)

809. Period of straw feeding experiments : The Bengal experiments were conducted without any green fodder in the first three stages. The poor results about digestibility must have been largely due to

the absence of vitamin, although straw itself is a bad fodder.

The experiments were as under.

A—Rice-straw only for	...	...	18	weeks
B— <i>Aman</i> rice-straw and rice- <i>kura</i>			18	„
C— <i>Aman</i> rice-straw and linseed-cake			12	„
D— <i>Aus</i> straw only	...	...	6	„
E— <i>Aus</i> straw with $\frac{1}{2}$ to $\frac{3}{4}$ lb. linseed-cake			6	„
F— <i>Aman</i> straw with green feeds of				
(1) Hyacinth ;				
(2) Napier grass ;				
(3) Guinea grass	...	...	18	„

It will be seen that only in experiments F. were green feeds introduced with the straw, but there was no cake in it. Still this experiment F., barring the abnormal feed in F(1) of water hyacinth, would have given an idea of how rice-straw as a feed behaved in combination with green grass. Unfortunately, this experiment was rendered valueless by being conducted on animals which had already lost their vitality by being too long kept on dead, unbalanced ration.

Experiment F(2)—*Aman* straw and green feed of Napier grass was conducted on animals D—3 and D—6. (397, 505, 655)

810. Same animals used over again : Looking up the experiment list it is found that these animals D—3 and D—6 were subjects of the following other experiments also :

D 3.

Exp. B. with *Aman*
straw and rice-*kura*

—18 weeks

Exp. C. *Aman* straw

and linseed cake—12 „

Exp. D. *Aus* straw

as single feed — 6 „

36 weeks

D 6.

Exp. B. with *Aman* ,
straw and rice-*kura*

—18 weeks

Exp. E. *Aus*

straw and

linseed-cake—6 „

24 weeks

—(397, 505, 655)

811. Loss of weight prior to green feed : The bullock D—3 was kept for 36 weeks on dead vitamin-less fodder and the bullock D—6 was kept for 24 weeks on dead vitamin-less fodder. It was fortunate that they could pull through these weeks on such life-less stuff. It was found that the bullock D—3 had a starting weight of 568 lbs. when he was taken in for experiment B. for 18 weeks. After its experience through experiments B. C. and D. for 36 weeks he came down from his original 568 lbs. to 469 lbs., thereby losing 99 lbs.

Bullock D—6 started experiment B. with 589 lbs., and after having had experience of experiment B. and E. for 24 weeks came down to 517 lbs., thereby losing 72 lbs.

812. Feeding-experiments lacked practical objective : These bullocks when they had lost already 99 lbs. and 72 lbs. after subsisting on an unnatural and deficient food were subjected to experiment F (3) with green feed. They, therefore, responded very little to

the reaction of the life-giving Guinea grass and their assimilations were poor as shown below :

TABLE-61

	N.	CaO.	P ₂ O ₅	K ₂ O	Na ₂ O	Weight
<i>D-3.</i>						
In-take	58.0	59.8	24.10	73.8	35.0	} -1.108 lb.
Balance + 7.3	+2.5	+3.241	-7.0	+2.8		
<i>D-6.</i>						
In-take	57.1	54.9	21.6	71.6	33.7	} +0.376 lb.
Balance +1.8	-1.3	+2.1	-20.5	-1.6		

The in-takes in this last F(3) experiment were principally from Guinea grass, they having eaten little of straw. Yet, one lost weight and another remained constant, and potassium was negative in both, and calcium and sodium also were negative in D-6.

Therefore, it is apparent that no conclusion can be drawn from the results of the experiments which would have been useful for guidance in the determination of a corrective for rice-straw fodders, the original intention with which the experiment had started. It is no wonder, therefore, that Wright in referring to these or similar experiments remarked that they lacked a practical objective in the following words :

"At Dacca the work has so far been largely devoted to the formulation of a new method of determining the digestibility of food-stuffs by means of regression equations. The maintenance requirement of bullocks have also been determined.

"Most of these investigations have been carried out with obvious care and by sound methods and the

scientific value of the results cannot be questioned. The broad impresssion created is, however, that much of the work lacks a practical objective, and that there is need for better planned and co-ordinated methods of attack."

It appears that more experiments on these lines were conducted. For, in the article in the "Indian Farming", it is mentioned that mustard-cake in combination with rice-straw was fed, which must have been after the first series of A. to F. experiments referred to above. But this experiment also proved unsatisfactory although "...judged from body-weights etc., it gave an indication for the better. But when the in-take of essential nutrients are carefully examined, it was a surprise to find that in spite of a considerably large in-take of potash, more was voided out than was provided in the feed. This behaviour has been noticed in a very large number of experiments, but the cause of it is yet under investigation." (397, 505, 655)

813. Part played by potash: "It may, however, be noted that potash forms a considerable part of the mineral fraction of body tissues. But when more potash was voided out than is supplied in the feed it may be related with a possible break-down of body-tissues. On the other hand, tissue break-down generally occurs when the feed-proteins lack the essential amino acids. In the present case, the feeds consisted of rice-straw and mustard-cake. Very little is known of the nature of the amino acids in mustard protein.

If it is deficient the body in its attempt to meet the physiological needs of its system will sacrifice a part of its tissue-protein, and in such a case the other associated components of the tissue, including potash, will necessarily come out as the products of disintegration...." (397, 505, 655)

814. Conclusion on defects of rice-straw: The defects of rice-straw as a feed were brought out in the last article referred to as under, with some of which the reader is already familiar :

Rice-straw—

1. Carbohydrates : The energy requirement is met.
2. Proteins . Deficient in it which can be made up from protein from other sources.
3. Phosphorus : Poor in it. Even this supply is of doubtful quality.
4. Potash : Contains large quantity which probably retards lime assimilation.
5. Calcium : Has a fair supply, but a large fraction of it is useless, being in the form of calcium oxalate.

The experiments on rice-straw so far have been of a negative nature. Its defects have been shown and proven. But these experiments are not far-going enough. In the cultivators' homes, in the rice-tracts, cows reproduce. The female calves grow and become

heifers and again reproduce mainly on rice-straw. It has not been found what factors were there that contributed to the successful rearing of calves, although in a poor condition. If the balance of calcium or potash were throughout negative, then there could be no growth. Therefore, the defects of rice-straw are to a certain extent corrected by the other feeds that the cattle in the area get. An insight into the various roles which these other feeds play might serve as clue to further improvements. (397, 505, 655, 794)

815. Suggestion about rice-bran : The experimenters have suggested that suitably to Bengal conditions, rice-straw should be fed with rice-bran as a concentrate together with a combination of cake, some green forage and a small quantity of powdered chalk to supplement lime-deficiency. It is a pity that digestibility trials have not been carried out on these lines, so that a practical feed could be hit upon that would contribute to a better growth and better make of the cows of the rice-tracts. The experiments, it is understood, are still going on.

816. Improving rice-area cattle : In the meantime my suggestion for improving rice-area cattle are as follows :

(1) To ensure the presence of plenty of *green grass* with rice-straw feed, say, 6 lbs. green feed equal to 2 lbs. dry for a 500 lbs. live-weight.

(2) To make up for deficiency of protein and phosphorus, some *oil-cake* is necessary, say, $\frac{3}{4}$ pound of cake or as an alternative some legume hay, about double the quantity.

(3) To make up for deficiency of calcium, bone-meal is to be used and not chalk or lime-stone as suggested by the experimenters. Bone-meal will provide both phosphorus and calcium in an absorbable form ; 2 to 3 ounces of bone-meal would be enough for a 500 lbs. cow.

(4) A small quantity, say, 1 lb. or less, of rice-*kura*, which contains about 20% of oil, should be included, as it is universally available and is practically cost-free to farmers. In place of oil-cake which has, however, to be purchased, legumin hay may be used, which will supply the necessary protein, and being rich in calcium, will be helpful for balancing.

(5) The excess of potassium in rice-straw is its most positive repugnant factor. It is wanting in protein, in assimilable calcium and in phosphorus. These are negative defects and can be corrected by the addition of the deficient materials. But with regard to potassium its defect is a positive one. It contains too much of potassium which retards calcium-absorption, and thereby upsets the calcium-phosphorus balance ; and what is more, it also causes sodium to be thrown out. The problem is how to take it off or counter-balance it. To counteract the almost poisonous action of potassium a larger than ordinary dose of sodium chloride or common salt is recommended. Here will be found a clue to one of the very urgent modifications in feeds. In rice-tracts more and more salt is to be given to the stock. It is not given. And here lies in my opinion, one of the chief causes of inefficiency. For a 500 lbs. cow, 2 ounces of salt would have to be

given ; 2 ounces per day means two seers of salt per month.

Bone-meal need not cost anything. Even when it has to be purchased, it is a cheap article. It should be manufactured in villages from the bones of dead cattle. After serving as a feed, if there is any excess feed, that will again come back to the soil in a better form as manure. Introduction of bone-meal and the understanding of the importance of common salt are the two special features for making rice-straw feed more useful and for the better growth of the cattle in the rice-tracts till such time as new researches do not show a way. I have found incalculable good come out of the use of these two materials. Salt for cattle-feed may be made duty-free, and thereby cheapened for extended use in improving the cattle.

817. Potassium—the offender : That potassium is the prime offender in rice-straw as a feed has been curiously brought out by experiments on rice-straw-alkali-treatment in the Izatnagar Institute by Dr. K. C. Sen and his colleagues who were carrying on experiment on the alkali treatment of straws for improving their feed-values. The result of their researches were published in “Indian Journal of Veterinary Science and Animal Husbandry”, December 1942, in which it was found that the alkali treatment of rice-straw improved its feeding value by amongst other things, the elimination of a large portion of the burden of its potassium. The experiments are interesting from several points of view, as giving

us insight into the working of some of the mineral-contents of straws.

818. Alkali treatment of cereal straws : Cereal straws are given a very low place in fodder. In fact, in other countries, where cattle-keeping has considerably advanced, straw is regarded as a food only in times of stress. Under war conditions when transport is difficult, when grass-lands are ploughed under for food production for human beings, the straws are looked upon as a source of supplying a large portion of the energy-requirement of the cattle. During the last Great War and after, Germany was trying to improve the cereal straws by alkali treatment. This work has been taken up subsequently by scientists in many other countries. Cereal straws improved if soaked over-night in a solution of 1.25 per cent caustic soda. It was found in England that there was difference in the growth of animals, fed with alkali-treated and untreated straw, the difference going up to 60 per cent or more in favour of the treated straw.

The subject is enticingly interesting as straws of cereals such as rice, wheat, barley, *bajra*, maize etc., constitute 80 per cent of the total organized roughage supply of the cattle of India (Sen & Ray, 1941). Out of the straws, rice-straw takes a special position because 25 per cent of the total cultivated area is under rice, and its straw forms the staple fodder of a very large portion of the cattle in India.

819. Calcium as an unassimilable oxalate : Dr. Sen took up the research work carried on in other countries and began experimenting on 'straws for

their improvement under alkali treatment. The blemishes of straw as a fodder are general. But rice-straw suffers from drawbacks which are peculiar to it. He observed :

"...Experimental work carried out in our laboratory (Izatnagar) shows that a portion of the calcium in paddy-straw is in the form of calcium oxalate, the major part of which cannot be metabolized in the body. The absorption of the rest of the calcium in paddy-straw is further hindered by the large amount of potassium which this straw contains. These factors which are almost absent in other cereal-straws makes the position of paddy-straw unique from the point of view of scientific study. Any treatment which can improve its nutritive quality and remove its inherent defects must be considered worth attempting at any time irrespective of whether it is war or peace."

In England under the stress of the present war, this experiment has been fruitful, and now alkali-treated straw is a regular article of feed there. Samples of treated wheat, oat and rice-straw were subjected to experiments for feeding, and the results were found on the total assimilation of all nutrients and minerals. (652)

820. Alkali treatment of straws : Straw was cut into one inch lengths and soaked one day in eight times its volume of water containing caustic soda equal to 10 per cent of the weight of the straw. For 80 pounds of straw 640 lbs. of water and 8 pounds of caustic soda were used. Next day, the water was

drained out and collected, in which was added a certain amount of water to make it up to 640 lbs. for the next treatment. In the next treatment this liquor was rejuvenated to caustic form from carbonate to which the caustic soda had degenerated, and the strength made up by fresh addition of caustic soda to the extent of about half the original quantity. Three successive treatments could be made from the starting solution after which fresh water is used.

The straw was washed thoroughly and fed. For experimental purpose the straw was dried to determine weight, and it was found that the loss in weight varied with the kind of straw.

Losses in weight on alkali treatment :

Wheat-straw	...	25 per cent.
Oat-straw	...	34 „
Rice-straw	...	25 „

The treated dry straw became yellower and softer to the touch. There was loss all along both in protein and carbohydrates by the alkali treatment.

TABLE-62

100 lbs. dry material.	Crude protein.	Ether ext.	Crude fibre.	Total ash.	N.-free extract.
Rice-straw—					
Untreated	2.68	0.83	40.4	8.57	47.19
Treated	2.51	0.60	56.0	7.25	33.61

The alkali soluble portions of straw had been washed out, carrying with them protein, carbohydrates etc., and therefore leaving the material richer in fibre.

821. Changes in minerals by alkali treatment :

TABLE—63

Paddy-straw 100 lbs. dry material.

	Calcium.	Magnes.	Potash.	Sod.	Phos.
Total before treatment ...	0.52	0.47	4.52	0.07	0.22
Total after treatment ...	0.66	0.46	1.18	1.3	0.11

It will be seen that calcium gained by the treatment. This was explained by the fact that the wash-water contained calcium which was retained and absorbed by the treated straw. Sodium also showed a gain. This was due to the fact that the straw had been treated with caustic soda which was a product of the sodium. The most prominent change, however, was in potassium which fell from 4.52 per cent to 1.18 per cent. The alkali treatment performed a wash-out of the potash. Alkali had gone into the cell structure of the straw and washed the potassium salt out of it. Shorn of this nuisance, rice-straw at once become a better feeding material.

On actual trial it was found that the digestibility of protein and carbohydrates had increased very much, and allowing for the loss in weight of the straw by the treatment, there was still much greater utilisation of the nutritive materials on the original weight of straw.

822. Mineral assimilation from treated straw :*TABLE-64*

	Nitrogen.		Calcium.		Phos.	
	Intake—	Balance	Intake—	Balance	Intake—	Balance
Un-treated						
straw ...	57.4	+4	23.8	+1.3	13.7	+1.3
Treated						
straw ...	53.3	+16.0	22.8	+3.7	11.0	+4.2

It will be found that less protein was taken in the treated straw, 53 against 57, still the retention was 16 against 4, i.e., 4 times more protein was assimilated from the treated straw. Similarly, calcium-assimilation increased from 1.3 to 3.7 and phosphorus from 1.3 to 4.2. This explained how the cows put in more weight when fed with treated straw, in another case fed with an addition of mustard cake. The average increase per cow of 666 lbs. weight was 5 lbs. with untreated straw and in an equal period with treated straw the weight increase was 22 lbs. (652)

823. Effects of excessive potassium in straw :
The above showed how materially rice-straw had improved under the treatment. In this connection, the above paper said :

“Certain evidences are available which point out the factors present in paddy-straw, responsible for a general deleterious influence upon metabolism. Thus the clinical symptoms of diuresis induced under the paddy-straw feeding has been attributed to the high potassium-content of the straw. To counteract the possible ‘washing out’ effect of

potassium on sodium and chlorine, a routine feeding of a comparatively higher dose of common salt supplement has been found necessary. The high potassium-content may also be responsible, as has been found in the present investigation, for the wastage *via* the kidney of a significant quantity of nitrogen, which would otherwise have been retained in the body. In support of this observation, the experimental evidence supplied by Richards, Godden and Husband (1927) can be cited. These workers have shown that excessive potassium in a ration decreases both the assimilation and retention of nitrogen. High potassium ingestion has further been proved by these workers to depress the absorption of calcium. Perhaps, a part of the chronic negative balance under paddy-straw feeding can be explained on this basis. The present investigation definitely shows that the alkali treatment removes a large portion, practically two-thirds of this undesirably high amount of potassium from the paddy-straw." (652)

824. **Effects of oxalate-content of straw:** "The large oxalate-content is another peculiarity of paddy-straw. Evidence has been collected in this laboratory to the effect that a major portion of this oxalate is in the form of soluble potassium oxalate, but a significant fraction is present as insoluble calcium oxalate. The insoluble fraction of oxalate in paddy-straw thus prevents the animal from making use of a significant portion of ingested calcium."

This alkali treatment has given a more accurate picture of what is wrong with paddy than was ever done before. (652)

825. Alkali treatment not economical : It is to be regretted, however, that though the alkali-treated cereal straw-feed has come to be taken as a normal thing in war-time England, out here in India, it has no possibility of adoption in actual practice. For treating 80 lbs., about one maund of straw, even if only 5 lbs. of caustic soda on the average were needed, allowing for recovery from the first two liquors, even then, the cost becomes prohibitive. Even if caustic soda solution is made out of soda ash or *saji mati* and lime, still the price corresponding to the required quantity of chemicals would be considerable and prohibitive. For the present the experiment has served to establish what is necessary to improve rice-straw. So long as nothing better is commercially available, the dependence upon an excess of common salt in the feed has to be urged to counteract the excess of the potassium-content of the straw. For this purpose, it would be the duty of the State to make common salt available to the stock-owners at a nominal cost and not to look for revenue at the cost of the health of the very 'mother of prosperity', the cow.

826. Problem of rice tracts : As for Bengal and other rice-tracts all over India with poor cattle, now that some light has been thrown on the cause of their stunted growth, it is up to the people of these tracts seriously to set about correcting the

draw-backs of the staple fodder-crop. Introduction of bone-meal and the practice of giving larger doses of salt should be popularised, and stress should be put on feeding green grass, and on growing leguminous crops in the paddy fields. Just a little before paddy is harvested, when the soil is soft with receding water, seeds of pulses may be broadcasted and a crop taken. The leguminous crop may be used as green fodder or may be harvested, and both the pulse and the hay stored for the cow to last the whole year. This, along with green grass and proper doses of salt and bone-meal, is expected to do the marvel of solving the problem of cattle-feed of the wet areas, and put their cows in line with the better cows of India. Rice-straw must cease to be the only or the principal feed. For roughages green grass and leguminous hays should have a significant place in the all-year round feeding of the cattle of the rice-straw tracts. (655, 794)

827. Rice-bran of little value: In this connection, another natural disadvantage of the rice-straw tracts in feeding cattle should also be noted. It is not the dependence on rice-straw alone that has caused the deterioration of the cattle; rice-bran is also largely responsible for the mal-nutrition. If rice-bran were a good concentrate then the animals of the rice areas could get from the cereal crop refuses something to support them. But as a matter of fact, rice-bran is not of much worth, as has been established from experiments carried out with it in Bengal. Rice-bran contains some oil, but is poor in protein and calcium ;

its phosphorus is insoluble, (903) and it has an injuriously high percentage of magnesium.

828. Wheat-bran helps wheat-areas : As compared with the poor quality of rice-bran, wheat-bran stands out in relief. Wheat-bran is a much superior article than rice-bran and, therefore, animals in wheat areas, although they do not depend on wheat-straws because there are other fodders grown there, get the very valuable concentrate in their wheat-bran, the opposite of which happens in the rice tracts.

The inferiorities of rice-straw and rice-bran have combined, in the absence of other relieving factors, to create the deteriorated cattle of the rice or wet areas.

829. Wheat-straw : Next in importance as food-crop comes wheat with its 26·2 million acres, as against 69·5 million acres of rice, and 186 million acres under total food crops. Wheat cultivation is distributed as under :—

Province.	Million acres.	Province.	Million acres.
Punjab	9·9	Sind	1·1
U. P.	7·9	Bihar	1·1
C. P., Berar	3·3	N. W. F. P.	1·0
Bombay	1·8	Bengal	0·1

Wheat straw is not quite as bad as rice-straw, although it is very much like rick-straw. The most significant matter about wheat-straw is that the cattle do not depend upon it as the only or the main fodder. The Punjab and the U. P. grow over two-thirds of

the entire produce. And in both these provinces very large areas are under fodder-crop. Out of the total of 10 million acres under fodder-crop in India, the Punjab alone accounts for 5 million acres against 31 million acres sown area or a little below one-sixth of the total sown area of the province.

830. Areas under food crop and fodder, and total sown area (million acres) :

TABLE—65

Province.	Area under food crop.	Area under fodder crop.	Total sown area.	Per cent. Total sown, area to fodders.
Bengal	24·0	·1	29·7	0·4
Bihar	19·7	...	23·8	0·0
Bombay	20·2	2·4	29·6	8·3
C. P.	19·9	0·5	27·2	1·9
Madras	25·0	0·4	36·9	1·1
N. W. F. P.	2·1	0·1	2·5	4·0
Orissa	6·1	...	6·9	0·0
Punjab	21·4	5·0	31·5	16·0
Sind	4·2	0·2	5·7	3·5
U. P.	38·0	1·5	44·7	3·4

The Punjab stands out very prominently with regard to its fodder production, followed at a great distance by the U. P. But the importance of wheat is greater in the Punjab than in the U. P. In the former, out of a total 21 million acres under food-crops, 9·9 million are under wheat, comprising nearly 46% of the total area under food-crops in the whole Province, whereas, in the U. P., the area under wheat is

7·9 million acres as against 38 million acres under food-grains comprising only 20 %. The wheat-straw problem as a fodder is, therefore naturally, thrown into the back-ground as compared with rice-straw.

831. Wheat straw an inferior feed : In the 1942 experiments at the Izatnagar Institute by Sen, Ray and Talapatra on the alkali treatment of straws, wheat and oat straws were submitted to the same treatment as described under rice-straw with equally satisfactory results. Wheat-straw contains like rice-straw little digestible protein. Its calcium-content is also low. But in phosphorus-content it is comparatively a little better than rice-straw and has less of potassium than rice-straw. (see Table 50, Page—711).

If the cows of the Punjab and the U. P., the two predominantly wheat areas, were to depend solely on wheat-straw as their main fodder, then it is difficult to say whether we could have seen the fine breeds that we now see there to-day, specially if the advantage due to the high nutritive quality of wheat-bran was denied to the cattle of these areas.

832. Joar or cholam straw—the great millet :

Joar feed : *Joar* or *cholam* forms one of the most important fodders used all over Bombay, Madras, the C. P. and the U. P. The number of acres under *joar* are given below :

Bombay	...	8·0 million acres.
C. P.	...	4·2 "
Madras	...	4·6 "
Punjab	...	0·8 "
Sind	...	0·4 "
U. P.	...	3·8 "

Joar is grown both as a food-grain and as a fodder. For fodder, it is harvested at the prime stage; while, when the grain is collected for food, the straw goes to make fodder. It can be very well kept in silage. Both in prime and ripe conditions, it can be successfully ensilaged as the Bangalore experiments carried out in 1932 showed.

Joar is a kharif crop sown from the end of February to July under irrigation, and from July to September as a dry crop. It can be followed by any crop excepting very exhaustive ones like sun flower. The soil should be well cultivated up to 3 to 4 inches, and firm beneath. The seed rate for fodder purpose is 35—40 lbs. per acre. It requires irrigation at intervals of 8 to 15 days, according to the season. If the season is very dry and if the plants are not stunted it may be fed just before flowering, but it is advisable to feed it after the grain is in the milk stage. The average yield may be expected from 200—400 mds. green or 50—100 mds. dry. The crop should be manured at the rate of 10 to 15 cart loads of farm yard manure. It is one of the cheapest fodder crops, and the animals relish it, when it is fed cut. It is also a practice to mix some legumen seeds at the time of sowing. Sundhia, Utawali, Nilwa are some of the good and early varieties. It makes good silages.

Joar is grown extensively in Northern India both under irrigation and without irrigation. It can be sown from May to June and can give three cuttings. It is a good material for fodder, and is equally good as a green feed, for silage, and as hay. It can be

sown as a follower of the rabi crop without preliminary cultivation in the Punjab. Ripe *joar*-straw can be stacked for years without serious deterioration. The *joar* of Madras is a special variety, and is superior to the common *joar* of the Punjab and the U. P. This variety gives a heavier yield and remains green till the end of November. Its usual yield as a fodder crop is 300 mds. per acre. In the Punjab it enjoys cheaper water-rate. It is rather an important crop in the U. P., where it occupies 10 per cent of the area under kharif crop. The principal *joar* tracts in the U. P. are the Jhansi, Allahabad and Agra divisions.

Extensive researches were undertaken on it at Cawnpore where several distinct types were cultivated and some types were separated.

833. Digestibility of joar and rice-straws : *Joar* and rice were tested for their mineral contents and their digestibility. The following results were found by Viswanath Iyer, Bangalore, 1934.

TABLE-66

Average analysis.

	CaO.	P ₂ O ₅ .	N.
<i>Joar</i> straw ...	0.382	0.227	0.543
Rice-straw ...	0.564	0.169	0.430

When used as a single feed *joar* behaved much better than rice-straw as will be seen from the following figures by the same author :

TABLE-67

		CaO.	P ₂ O ₅ .
<i>Joar</i> straw	Intake	16.0	17.7
	Balance	+2.61	+2.57
Rice straw	Intake	27.9	11.1
	Balance	-2.42	+0.09

It is a notable fact that *joar* gave a positive balance both with regard to calcium and phosphorus. With so low an intake as 16 grams of calcium, there was a positive balance of 2.61 grams, and with phosphorus with an intake of 17.7 grams there was a positive balance of 2.57 grams. As against this, rice-straw with an intake of 27.9 grams of calcium gave a negative balance and in phosphorus with 11.1 gram intake the balance was about nil, being 0.09.

When some green grass and minerals were supplied as supplements, the balances were largely positive with *joar* as regards calcium. Rice-straw here did not behave as badly as in the case of the Bengal experiments. With green feed and mineral supplement of calcium and phosphate, rice-straw also showed a positive balance. And so too it might have been in Bengal if green grass and some bone-meal had been included in the feed. *Joar* straw, however, stands out much superior to rice-straw in the Bangalore experiments of 1934. (652)

834. *Joar* in other lands : *Joar* is called Sorghum or Kafir in America. The Sorghum of America are of two varieties, the sweet Sorghums which have their stems filled with sweet juice, and the grain Sorghums

with juice that is sour or slightly sweet, with a more pithy stem. The grain Sorghums are used both as grain for cattle-feeding and for forage feeding. They are of great importance in America in the central and southern parts of the Western plains. Morrison observed :

“.....In fact, success in stock-farming throughout this great section depends largely on the Sorghums. Because they are much more drought-resistant than corn, they have largely taken its place in those portions of this region that have too little rain-fall for corn” (maize).

“The Sorghums are important in India, China, Manchukuo and Africa. In these countries the grain is used widely for human food in place of wheat or rye. In Africa where Sorghum grain is one of the chief foods of the natives, the Sorghums are grown on the dry plains, in the oasis of the Sahara, on high plateaus, in mountain valleys and in tropical jungles. Their forms are as diverse as the conditions under which they grow, the plants ranging in height from 3 to 20 feet with heads of different shapes varying from 5 to 25 inches in length. Though Sorghum originated in the tropics it is now grown chiefly in the temperate zone.”
—(Morrison—*Feeds and Feeding*. 1942.—P. 286-'87).

The yield of *joar* as a fodder crop under good conditions is 400 mds. per acre. The seed necessary is 30 to 36 seers per acre. (652)

835. **Bajra or Cumbu straw :** The area under *bajra* is 12·5 million acres and is distributed as under :

Bombay	...	4.0	million acres.
Punjab	...	2.6	,,
Madras	...	2.6	,,
U. P.	...	2.1	,,
Sind	...	0.8	,,
C. P., Berar	...	0.1	,,
N. W. F. P.	...	0.1	,,
Others	...	0.2	,,

Total— 12.5 million acres.

It is a hardy crop, generally grown on poor soil. The grains are used for human food. The stalks are used as fodder. The dry stalk of *bajra* or *karbi-bajra* is fed to the cattle and is a stand-by in times of famine or scarcity of fodder. It can be used as a green fodder. Several cuttings may be taken. A crop of green fodder may be raised in 60 to 80 days after sowing. (Read. *Agriculture & Live-stock in India. January, 1936*).

836. Ragi straw : There are under *ragi* 3.5 million acres all over India distributed as under :

Madras	...	1.6	million acres.
Bombay	...	0.6	,,
Bihar	...	0.6	,,
Orissa	...	0.3	,,
U. P.	...	0.2	,,
C. P.	...	0.1	,,
Others	...	0.1	,,

Total— 3.5 million acres.

Ragi is most generally used in Madras, and is fairly well-distributed in other provinces. The millets are used as human food, while the straw or stalks are used as fodder.

Dr. Warth carried out mineral assimilation experiments on *ragi* at Bangalore in 1932. He found *ragi*-straw to contain the following :

CaO	...	1.136	per cent
P ₂ O ₅	...	0.193	„
N	...	0.511	„

837. Digestibility trials with *ragi* straw : The digestibility experiments were conducted in three stages :

- (1) Straw as single feed ;
- (2) Straw with supplement of calcium phosphate ;
- (3) Straw with calcium phosphate and green feed.

The fodder was found to have good assimilability of lime. Phosphoric acid was on the border line of sufficiency. When calcium phosphate was added, calcium assimilation increased, owing probably to the introduction of phosphates. Dr. Warth concluded from this that phosphoric acid influences lime assimilation.

Ragi is a much better type of fodder than rice-straw or poor hay.

In Bengal, in the Agricultural Department trials, *ragi* was found to yield 250 mds. of dry fodder per acre. The seed required was 13 to 15 seers per acre.

There is an interesting description of *ragi* in "Buchanan's Journey" (1807)—Vol. I. P. 102, while he was at Seringapatam. After describing the cultivation of *ragi*, the distinguished traveller proceeded to

describe the use of *ragi* as food, and concluded by referring to the superiority of *ragi*-straw over rice-straw.

838. Buchanan on ragi straw : "For all kinds of cattle, the *Ragy*-straw is here reckoned superior to that of rice. My *Madras* bullock-drivers dispute the point, but I am inclined to think that they are wrong ; for the people here (*Seringapatam*) have much experience of both kinds of straw, while the *Madras* people are only accustomed to that of rice, or at least have never seen the *Ragy*-straw used except in our camps, where many causes contributed to render the mortality among the cattle very great."

There is no doubt that the *Seringapatam* people were right, and Dr. Buchanan's bullock drivers were wrong ; for *ragi* is a fodder much superior to rice-straw, as modern nutrition experiments have proved.

839. Maize or corn straw—Makki or Makai : The area under maize all over India is 5·6 million acres, distributed as under :

U. P.	...	1·9	million acres.
Bihar	...	1·5	,,
Punjab	...	1·1	,,
N. W. F. P.	...	0·5	,,
Bombay	...	0·2	,,
C. P., Berar	...	0·1	,,
Madras	...	0·1	,,
Others	...	0·2	,,

Total— 5·6 million acres.

It is a high-yielding *kharif* crop, thriving on good loamy soil. Light and sand soils are not suitable for it. It can be sown from May to August, and in suitable ground practically throughout the year, as a green fodder crop. It grows faster than *joar* and gives an yield of heavy succulent green fodder. It is very suitable for silage. It cannot stand water-logging, but will tolerate heavy rain-fall.

Maize can be sown practically all throughout the year, but in very cold season it does not do so well. It can follow any crop provided the land is manured with 15 to 20 cart loads of farm yard manure per acre. The seed rate is from 35 to 40 lbs. per acre. It can be fed when the grain is just getting milky. Stovers after the cobs are harvested make very poor feed. 200 to 400 mds. of green fodder may be expected as the yield per acre.

840. Analysis of maize straw :

Digestible protein	...	4·7	per cent
Starch equivalents	...	52·3	lbs.
CaO	...	0·73	per cent
P ₂ O ₅	...	0·63	,,
K ₂ O	...	1·6	,,

It is an excellent fodder-crop. When grown for corn, the stalk is used for fodder. In America, the corn holds the position of honour amongst the fodder crops.

“Indian corn (*Zea Mays*) is the imperial agricultural plant of America. Wherever conditions are favourable for its growth, it excels all other

forage-crops in average yield of dry matters and of digestible nutrients. . . . in these respects it even slightly surpasses alfalfa, the queen of the legume roughages. This giant annual grass reaches a height of 7 to 15 feet in 4 or 5 months' growth, producing under favourable conditions 10 to 15 tons of (270-400 mds.) green forage per acre, containing 4,000 to 9,000 lbs. of dry matter."

841. Maize straw in other lands: "Corn is an exceedingly adaptable crop, and it is raised for grain or for forage on more than two-thirds of all the farms in the United States."

"...Wherever the climate and soil are suitable, it surpasses all other cereals as a feed-grain. Not only is the average yield of grain much higher but also corn grain ranks first in feeding value and the corn stover (stalks) is worth much more per acre for stock-feeding than the straw from small grains. . ."

"When corn is planted thickly, a tremendous yield of forage is secured under favourable conditions, with relatively little grain. This forage can be cured into nutritious dry fodder which approaches hay from grasses in feeding value."

—(Morrison—*Feeds and Feeding*. 1942.—P. 277).

Experiments on growing maize for fodder were made in Bengal by Gossip.

"In 1927-28 a collection of maize types was made and in comparative tests it was found that a few types of Kalimpong maize and some of the silage corn from the southern States of U. S. A. gave promising results. In further tests the

American varieties gave higher out-turn than Kalimpong types."

The Bengal Bulletin No. 7 of 1938 gives the yield of maize at 400 mds. per acre, which is equal to that of *joar*. Gilling mentions that the fields have to be weeded, but prefers *joar* to maize (in the Punjab).

842. Oat-straw : The acreage under oats is not separately shown. It is grown as a fodder-crop in the Punjab and in some parts of northern India. The oat is harvested before the seeds are fully ripe ; therefore, even when grown for grain, the straw left over is richer than most other cereal-straws. Read has praised oats in glowing terms. It is an irrigated crop and could be grown more largely as a fodder but for the water rates, as fodder rates are not allowed for oats in the Punjab.

Oats are recognised nearly all over the world as probably the most important of fodder-crops. The seed is a first-class concentrate for all classes of live-stock, and it is an extremely valuable and versatile fodder-crop. Great Britain produces 2 million tons of oats, and imports also a good quantity for feeding the live-stock.

The United States of America produces 185·7 million tons annually and the bulk of it is consumed internally for the live-stock, only 3 per cent being used for human consumption.

South Africa also grows oats largely, where in some parts, it is the staple food of all live-stock. Northern India-grown oat-fodder showed the following content of proteins :

Oats green		12·07	per cent
„ hay	...	8·01	„
„ bhusa	...	4·94	„
„ seed	...	10·94	„

In the opinion of Read, oat cultivation has not extended in the Punjab because of the very high water-rate on it.

In the 1942 experiment at Izatnagar on alkali-treatment of straws, oat-straws were included. (818) It showed a higher percentage of total carbohydrates left over the treatment than wheat or rice-straw.

Oat-hay has the following digestible and mineral contents :

TABLE—68

Digest. crude protein.	Total Digest. carbohydrate.	N. R.	S. E.	CaO.	P ₂ O ₅ .	K ₂ O.
2·4	64·0	25·7	46·9	·46	·38	2·44

843. Legume hays : In India the cattle are obliged to depend very largely on cereal straws, which is a misfortune. The corrective lies in using as much as possible of legume hays. Even in countries where straws, robbed of their grains, are discounted as cattle-feed, where fodders are grown and liberally fed, there also much stress is laid on feeding legume hays in addition to, or in replacement of, the ordinary forages. How much more necessary is it in India to introduce legume hays in feeds, where life-less straws form the principal roughage!

The legume-hays provide hope for the improvement of the deteriorated cattle of the villages, whether of recognised breeds or of mongrel ones.

Legumes may be fed on the soil by tethering the animals on the margins of the fields and allowing them to advance day after day up to specified distances. They may be cut as green fodder and immediately fed or silaged. They may be cut and dried into hay and stored for stall-feeding, mixed with other fodders.

844. The proteins of the legumes : The legume-hays and pasturage are richest in protein of all common roughages. The protein-content of the leaves of legumes is much higher than that of the stems, and the nutrients of the leaves are much more digestible than those of the stems. When a considerable part of the leaves are lost during drying or transport, then the most valuable parts are wasted, and the loss is much more than what the bulk or weight would indicate.

The protein of the legumes are richer in quality than those of the cereals, and effectively complement the deficiencies of proteins from other sources. It is held that cattle, fed on the proteins of legumes, cannot suffer from deficiency in the quality of the protein, if a proper quantity is fed. It is a peculiar characteristic of the proteins of legumes that the ruminants can make biologically the best use of them. They have a special biological value for ruminants which they have not for non-ruminants like the horse or the pig. (607)

845. Legumes and calcium-phosphorus : Legume roughages are the richest in calcium. If a sufficient quantity of legume roughage is fed, calcium deficiency is not likely to occur. The total available digestible calcium in the various legume roughages can be found out from the Table in Para 927. One draw-back with the legume roughages is that they are not sufficiently rich in phosphorus. A supplementary source of phosphorus will have to be sought for if the phosphorus-content of legumes falls short of the requirement. Bone-meal is normally that supplement, as it contains calcium and phosphorus in the most assimilable form.

846. Legumes and soil fertility : It is well-known that legumes make nodules on their roots which harbour nitrogen-fixing bacteria. (607) These bacteria take nitrogen from the atmosphere and build the proteins for the plant as also serve to enrich the soil from the stubbles and roots left with the nodules in the soil. Here lies the benefit of growing leguminous crops in rotation with other crops. In order to specially enrich the soil, the practice should be to grow leguminous crops and plough up the green crops and mix it with the soil. This helps to feed the soil with much more nitrogenous manure than the harvesting of legume crops from the soil. If legumes are rotated with cereals, it has been found that the soil maintains its fertility without any addition of manure. Not only do the legume roots supply nitrogen to the soil but they make the soil-nitrogen more active and, therefore, more available. More

practical advantage can be taken of this fact by rotating legumes with other crops than by continuing to grow legumes on the same soil year after year. The effect of the growing of legume-crops on the same soil is not 'cumulative and, therefore, year to year growing of legume in rotation with cereal or other crops is of the utmost advantage.

847. Bacteria for nitrogen-fixing : The use of legume-crops for increasing soil fertility is, however, conditional. If there is nitrogen-fixing bacteria in the soil, then only can the legume plants harbour the bacteria on their roots and enrich the soil. Otherwise, a legume-crop will feed upon the soil-nitrogen as any other crop and fail to contribute anything to it. It may happen that a soil may be so poor or so devoid of the particular bacteria necessary for that legume, that the plant may not grow well, and remain stunted and unthrifty, and become useless for harvesting.

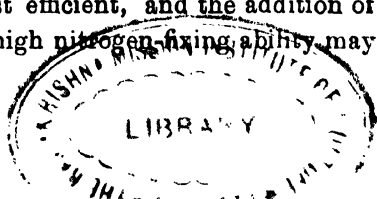
Not only should the soil contain nitrogen-fixing bacteria for the development of a legume-crop, but the bacteria should be of the proper strain necessary. There are many strains of them. Some strains are highly beneficial, and others are not so effective. It is, therefore, a problem as to how to have a convenient growth of legume by ensuring that proper bacteria remain present at the roots of the developing plants. The solution of this problem lies in inoculation. The seeds may be inoculated with the bacteria from the nodules. These seeds on germination begin to multiply bacteria. The plants

grow well and yield a rich harvest of nodules in the roots. Bacteria thus planted once in a soil have the capacity of travelling to neighbouring fields where even un-inoculated seeds show good growth and produce nodules similar to those in the plants on the inoculated soil or from inoculated seeds. Different legumes have different bacteria.

848. **Inoculation with bacteria :** A Department of Agriculture Bulletin of Canada reproduced in the "Indian Farming" March, 1943, placed the matter of inoculation in a simple form.

"The principle underlying inoculation is simple. It consists of the addition to the soil of useful bacteria which are able to penetrate the rootlets of young plants where they form characteristic swellings known as nodules. Here the bacteria live in close association with the plant, enabling it to use nitrogen from the air. Without the proper bacteria, plants would have to take all their requirements of this valuable element from the soil. Crop yield, crop quality and the soil itself may all benefit from inoculation.

"Where a legume is grown for the first time, the proper bacteria are often lacking, and inoculation is strongly advised Even if nodule-forming bacteria are naturally present in the soil, inoculation may be of value. Investigations have shown that the natural bacteria are not necessarily the most efficient, and the addition of a 'good' strain of high nitrogen-fixing ability may be of advantage.



"In cases where a crop has not been grown for a number of years, inoculation is to be recommended. In the absence of the legume plants the bacteria tend to die out in soil. ...In any case, re-inoculation is advisable after a lapse of three or four years. Another point brought out by investigational work is that it may take a season for the bacteria to become well-established in some soils, and that the benefit may not be visible until the second year with such a crop as alfalfa.

"Inoculation is only one factor in successful legume-crop production and cannot be expected to compensate for poor seed, acid soil, or poor cultivation methods. It does help in getting a legume stand well established, and under some conditions may mean the difference between success and failure.

"Treatment of seed is simple and is cheap. Reliable cultures are now available commercially in Canada and may be obtained from most of the larger seed houses. ..."

We are very far behind in India. So far Berseem inoculation has made some headway in the Punjab. (856)

849. Berseem—Egyptian clover : Berseem was introduced in India in 1894 and in the Punjab in 1901. It is an irrigated leguminous crop. It has now become wide-spread in the Punjab. It is a very heavy yielder, yielding about 1,000 mds. per acre. It has a capacity to yield repeated cuttings at short intervals.

Berseem is sown in September to November, and repeated cuttings, about 6 or 7 times, may be taken up to May. It provides a fodder in summer when it is difficult to get green fodder for the cattle.

The land is well prepared by frequent cultivation and manured with 20—25 cart-loads of well-made farm yard manure. In new plots it is advisable to inoculate the soil with 5 to 10 cart-loads of soil on which Berseem was previously grown. The seed at the rate of 25 to 30 lbs. per acre is mixed with earth and is broadcasted in beds prepared for the crop. The crop is frequently irrigated every ten days, according to the season. The crop is cut when about a foot and a half high, and cuttings are repeated till the hot season sets in well. Out-turns as high as a thousand maunds per acre are reported. In India it is not found profitable to turn it into hay or silage. The seed is only harvested in places where the cold season extends to a long period. It is a very rich fodder and helps the flow of milk.

850. Nutrients in Berseem : The protein-content of green Berseem is 18·38 per cent on dry basis. The dried hay contains protein to the extent of 14·70 per cent:

TABLE—69

Digestibility and mineral contents.

Digestible Protein.	Total Diges. Nutrient.	N. Ratio.	S. E.	CaO.	P ₂ O ₅ .	K ₂ O.
10·29	65·79	5·4	47·3	2·07	0·65	3·89

Berseem hay practically behaves like a half-concentrate containing as much as 10·29 per cent digestible protein. Its calcium-content is very high, being 2·07, whereas phosphorus is not bad being ·65 per cent.

At one time it was thought that Berseem cannot seed out properly in the Punjab, so that every year fresh seed had to be brought from either Egypt or the North Western Frontier areas. But now it has been found that Berseem seeds successfully in the Punjab. The difficulty hitherto was that, by cutting the plant several times, when it was allowed to seed, the seeds did not mature, and therefore could not germinate. Now seeds are obtained from the Punjab dealers.

As a matter of fact, Berseem has become the great success that it is, only after laboratory work was done by Ram Singh Sarkaria at Lyallpur, reported in the "Agriculture & Live-stock in India"; January, 1933, introducing cultures for inoculation.

851. Inoculation necessary and possible in Berseem : It is advisable to sow inoculated seeds. Cultures for inoculation are obtainable from the Agricultural Research Institute, Lyallpur, Punjab. For cultivation, selected seeds have to be purchased and inoculated with the culture from the Institute, according to its directions.

852. Viability of Berseem seeds : All seeds of Berseem are not equally viable. Those with a yellow colour are the best, next are the reds, and last are the brown seeds—the viabilities being approximately 90 per cent for the yellow, 50 per cent for the red and 25

for the brown. Certain plants should be reserved for seed-yielding and not subjected to cutting for fodder, for the deterioration of the seeds increases if the plants are subjected to cutting for fodder at its growing stage.

Berseem cultivation with inoculated seeds has done great good to the cattle of the Punjab and more is expected with the rate of increase in its cultivation.

Senji, another leguminous plant, was in favour in the Punjab as the most valuable fodder-crop. But Berseem is replacing it on account of its superior yield. Much work has been done on this subject by the Agricultural Department of the Punjab. J. C. Luthra, I. A. S. of the Punjab Agricultural College, has done considerable work in the matter of seed production and selection. Improvement work on cultures are also being successfully carried out by the Department.

853. Berseem at Pusa ; Berseem was introduced in Pusa in 1917. Gradually its cultivation extended to 130 acres along the river bank of the Pusa farm. Wynne Sayer reported in 1936 about Pusa work on Berseem (*Agriculture & Live-stock in India. July, 1936*). He wrote that it had been growing continuously in those 130 acres and formed an important cold weather crop for the whole of the stock maintained on the Pusa estate.

The yield in those days were much smaller than what has been obtained recently in the Punjab with inoculated seeds. In 1936 at Pusa, 4 cuttings each of 90 mds. were received per acre, totalling 360 mds. Pusa Berseem had to be mixed with dry oat-straw on

account of its having too much of water. The continual rotational grazing on Berseem plots made a very large difference in the total yield of milk and in the general condition of the Pusa herd.

854. Progressive ripening and nutrients in Berseem: In 1941 Das Gupta contributed a paper on the effects of progressive ripening of Berseem on its protein and mineral contents (*Indian Journal of Veterinary Science & Animal Husbandry*. March, 1942). He found that the protein-content was highest by the 9th week and stood at 26.68 per cent, and decreased to 15.8 per cent on the 24th week. Ether extract also decreased with growth, while fibre-content increased from 14 to 28 per cent or nearly doubled itself. Lime gradually increased from 2.0 per cent on the 9th week to 3.6 per cent on the 18th week, after which there was a gradual fall. Phosphate decreased with maturity inversely to calcium and fell from .7 per cent on the 9th week to .4 per cent on the 19th week, after which it became steady. The growth, however, was very little on the 9th week, being only 8 inches. It was 27 inches on 13th, 39 inches on the 17th, and 50 inches on the 22nd week. Flowering began on the 17th week from which period the deterioration seemed to stay, and the condition seemed to have steadied. The results are, however, of a tentative nature, being carried out on one plot only.

Analysis figures (850) show that Berseem contains a very heavy percentage of potassium, being 3.89. As it can be successfully used as a single feed, it has to be concluded that the excessive potassium in Berseem

does not exert any deleterious effect on the system. Knowledge on the subject of potassium metabolism is meagre. Much more research work will have to be carried out before anything very definite about the effects of potassium in fodder can be determined. For the present, the fact remains that potassium in cereal-straws is a great draw-back, and its removal improves the nutritional-value of the cereal-straws.

855. Soy-bean fodder : Soy-bean is a legume. Its seeds are used as human food, and the hay is used as rich fodder. Soy-bean can be raised entirely as a fodder crop. It will grow on almost any soil and can thrive on without irrigation. It can be successfully cultivated even in tracts of heavy rain-fall like Bengal.

As a legume, soy-bean forms nodules containing bacteria and thereby enriches the soil. Like Berseem soy-bean can improve in yield and in its capacity for enriching the soil by inoculation.

856. Inoculation of soy-bean seeds : A Press Note of the Agriculture Department of Canada throws interesting light on soys-bean inoculation (*Indian Farming*, August, 1943).

"The soy-bean plant is a legume and like other legumes gathers nitrogen from the air, which is stored in the roots. It is both desirable and economical to obtain as much atmospheric nitrogen as possible to relieve the demands made upon the soil nitrogen supplies.

"The medium through which this atmospheric nitrogen is obtained and made available to the plant is bacterial. When present in the soil, these

bacteria multiply on the roots of the soy-bean plant and form pea-like bodies called nodules. These nodules are visible to the naked eye, and when present are proof of successful inoculation. If nodules are not present in abundance, inoculation has not been successful, and the full advantages of a legume-crop are not being realized. The fact that the soil has been inoculated for clover or alfalfa is of no value to the soy-been crop. . . ."

"Soy-bean seed should be inoculated before planting. Cultures for inoculating soy-bean seed may be obtained from most commercial seed houses in Canada. Simple directions for using cultures are provided by the manufacturers. It is important to prevent inoculated seed from coming in direct contact with sun-light, as far as possible.

"When soy-bean crops show a tendency to become pale and yellowish in mid-summer, poor inoculation may be the cause. In any case, it is a wise procedure to pull up carefully a few plants in each crop and examine the roots for nodules. Inoculation of a field will generally last for several seasons, but considering the small labour and expense involve in this operation in comparison to the benefit derived, frequent periodic inoculation will be found advisable."

It is up to the Government of India through the I. C. A. R. and the Provincial Governments to make full use of the scientific discovery about the benefits of inoculation and arrange for the inoculation of the seeds not only of soy-bean or Berseem, but of all

legume pulses so that their productivity may increase and the soil get more nitrogen through them.

Soy-bean thrives in very diverse climates. In most districts of Manchukuo soy-bean occupies between 45 and 60 per cent of the cultivated area. It is gradually making a foot-hold in America. In most of the corn-growing districts of the United States, soy-beans are the most valuable and important legume-crop for hay. The yield is 30 to 60 mds. of hay per acre. In America soy-bean is harvested just when the seeds are ripening, and the seeds and all are fed. Here in India, the seeds are kept for human consumption. The hay will be the poorer for that. Still, what is left after the removal of the seeds will be of considerable value as fodder. And to this is to be added the increased manurial effect on the soil. (848)

857. Senji—Indian clover : Senji is the leguminous irrigated *rabi* crop of the Punjab. It does not do well in hard soils. It is usually sown in October between rows of maize and cotton in the latter stage of their growth. The crop is harvested in February-March. Senji improves the soil and is very beneficial to the following crop. It yields 16,000 lbs. of green fodder per acre and is highly prized for milch-cattle. It is mixed with some dry stuff for feeding as it is too rich in protein and in fermentive carbohydrates to be fed wholly by itself in the green stage. It can be dried to hay, and stored.

858. Pea hay : Pea hay is an excellent legume-fodder, and if grown for fodder, it may be used green or cut and dried into hay. It may be sown in October

or early in November in drying-up rice-fields in the wet areas. It is sown as a *rabi* crop for its pulse, and will grow anywhere. The hay contains 10·9 per cent of total crude protein, and yields 200 mds. of valuable green fodder per acre. In the Punjab it is sown with oats, and the combination makes an excellent green fodder. It is specially useful in improving milk-yield.

The cultivation of leguminous crops like pea and other pulses is imperative in the wet or rice-areas to improve the nutritional quality and quantity of feeds.

The other food pulses like gram, *khesari* (*Lathyrus*) *kalai*, *mung*, all fall under the same category as the pea and should be cultivated as a winter-crop, particularly as a precursor to the next paddy-crop.

859. Arahār—Pigeon pea—a drought resister : This belongs to the legumes but is a perennial plant although it may be cultivated as an annual. It is sown in rows with cotton or *ragi* in Madras. The purpose of this arrangement of sowing shows the intense foresight of the cultivators. The following passage is from "Buchanan's Journey" (1807) who undertook the journey in 1800 A. D. :

"The ploughing commences whenever the first occasional showers in the spring have softened the soil sufficiently to receive the plough. From that period till the 13th of *Jyaistha*, or 5th of June, the field is ploughed from four to six times, according as it may be found clean or foul. The dung is then given, and ploughed into the soil. When the rains begin to be heavy, the seed is sown broadcast and covered by the plough. ...

Next day single furrows are drawn throughout the field, at the relative distance of six feet. Into these is dropt the seed of either *Avaray* or *Tovary* (Pigeon pea, *Arahar*) which are never cultivated by themselves ; nor is *Ragy* ever cultivated, without being mixed with drills of the leguminous plants. The seed of *Avaray* or *Tovary* is covered by the foot of the person who drops it into the furrow. . . . According to the quantity of rain, the *Ragy* ripens in from three to four months. The *Avaray* or *Tovary* do not ripen till the seventh month. The reason of sowing these plants along with the *Ragy* seems to be that the rains frequently fail, and then the *Ragy* dies altogether, or at least the crop is very scanty ; but in that case, the leguminous plants resist the drought and are ripened by the dews which are strong in autumn. When the *Ragy* succeeds, the leguminous plants are oppressed by it and produce only the small return. . . . but when the *Ragy* fails, they spread wonderfully and give a very considerable return."—(P. 100-101)

Arahar or Pigeon pea, cultivated as an annual crop, will give plenty of rich leaves as fodder besides the pods which are used as human food as a pulse. The stem is woody and only the leaves and tender twigs are useful as fodder. Being a legume it enriches the soil. Cuttings can be taken four to six times a year. There is great possibility for the *Arahar* or Pigeon pea of being used as a fodder-crop. It is a leguminous plant which is perennial and can stand on the soil for four or five years without its stem being woody.

Its roots go deep enough to resist drought. These are three great assets, and in this matter it stands parallel with Lucerne, which is an exotic. Mention may be made about the drought-resisting capacity of Lucerne in common with *Arahar* or Pigeon pea.

860. Arahar compared to Lucerne : Morrison in *Feeds & Feeding* mentions that the great yields of Lucerne in some of the non-irrigated semi-arid sections of America are due to the fact that it sends its roots deep into the sub-soil, drawing from great depth moisture which has been stored there. In the dry climate, this brings about a great depletion of the sub-soil moisture. "For example, in Nebraska experiments it was found that in a 6-years old field of alfalfa the moisture in the soil had been reduced to a depth of 35 feet."

Nothing like this can happen out here, because of replenishment of the moisture of the soil by the subsequent monsoon season even if one or two would fail. But what this points to is that *Arahar* as a fodder crop may be used with equal advantage and better, because it is indigenous, and Lucerne is exotic and it requires time to establish Lucerne in the soil, whereas *Arahar* may be grown without difficulty at any time. The fodder possibilities from *Arahar* are unexplored and invite attention.

861. Lucerne : Alfalfa : Rizhka : It is a leguminous fodder-crop but perennial like Pigeon pea. It grows in medium and heavy loam soils. It requires plenty of water but cannot stand water-logging. It is sown in September and October and will give seven to

eight cuttings per annum. The yield is heavy when it has properly taken to the soil, and each cutting may go up to 12,000 pounds per acre. There are broadly two varieties, one annual and the other stands for three years.

The root of this plant goes deep and is, therefore, a drought-resistant crop, after it is well established. In times of water scarcity Lucerne will remain green long after other crops have begun to wither. It is resistant to extremes of heat and cold.

It is difficult to est it on some soils, because, perhaps, of want of proper bacteria. But, if it is cared after and allowed to stay on, it will do better in successive seasons. A better way would be to inoculate Lucerne seeds. Mr. Read highly recommends the growing of Lucerne and says that no farmer sho be without a plot of this prolific crop.

It contains 16.3 per cent of digestible protein and 55.9 per cent of total digestible nutrient and has 37.7 lbs. of starch equivalent. It has 1.7 to 2.8 per cent of CaO , and 0.79 to 0.74 er cent of P_2O_5 on the average, and has a high percentage, about 4, of K_2O .

Mr. Read recommende cutting of the crop when it is half bloom. Animals may be tethered and fed from the pasture. After 4 5 years it should be ploughed up, for the stem become woody after that.

862. Vitamin A in Lucerne : It is famous for its vitamin A content as a green forage or as a shade-dried hay. When properly developed it is an unsurpassable fodder-crop, having a high percentage

of protein of the highest quality. It is rich in calcium too. Its cultivation in America is going up by leaps and bounds. It requires water, but can be grown as a non-irrigated crop on account of its habit of deep rooting. So efficient is its power of extraction of moisture from the soil that if not replenished by rains, the soil continues to lose moisture and becomes unfit for its growth or for anything else if it is standing year after year. Where there are good showers of annual rain-fall, there is no risk of depletion of subsoil water by it. There are several varieties, and the Provincial Agricultural Departments will be able to advise which is the best variety for the soil for which it is wanted. (612)

863. Shaftal, Kabuli clover : It is an irrigated *rabi* crop of the Punjab. It is similar to Senji, but will give cuttings which may go up to the dry weather. This is valued for the reason that it gives some dry fodder at the time of fodder scarcity.

Shaftal is sown in October and the first cutting is available in February. It yields 12,000 lbs. per cutting per acre for two or three cuttings. (*Read*)

864. Guara, Cluster Bean or Field vetch : It is a leguminous pulse of the rainy season crop. It is sown under irrigation between April to June and also during the rains. The sowing may be continued even up to August. It is a sixty-days yielder giving a crop of 12,500 pounds to the acre. It is a good crop for green manuring. (*Read*)

865. Cow peas, Chavli : It is a leguminous crop, and is best sown early with *joar* or alone. When

irrigated, green fodder of 12 to 16 thousand pounds per acre may be obtained.

Several varieties were experimented upon in Bengal. One variety with black seed was the earliest. It comes to flower in the *rabi* season within 40 days of sowing. Even under adverse conditions it becomes ready for feeding within two months. Work has been going on upon this crop in Bengal. In the Punjab it has made head-way.

866. Grass : Grasses are the primary support of the cow. There is nothing like grazing on good pastures for the health of the cow and of her progeny. By domestication man has imposed extra duty on the cow, of which she was free in the state of nature. This extra duty has necessitated the use of concentrates where simple grazing cannot maintain her. Besides, the use of dry fodder is unnatural. Only by the addition of a portion of her natural food to the stall-feeding of straws, namely, green grasses, leaves or legumes, can she be kept in a state of health and efficiency.

Unfortunately many farmers do not know all the virtues that are there in grazing and are, therefore, ignorant of the difficulty in which a cow is placed for want of proper feed, through insufficient grazing.

By now it has become known that there is a progressive deterioration in the feeding quality of grass with its advance in age or growth. The younger it is, the richer it is. This feature is dealt with in some detail hereafter. There are many other nutritional

factors about grass and grazing of which only a faint idea exists at present.

867. Undiscovered food factors in natural food : Fraser's views (1935) on the subject are given in an abstract in "Indian Journal of Veterinary Science & Animal Husbandry" March, 1937.

"...where an animal is to be used for breeding, then it should be fed as nearly as possible on its natural food, and it is highly probable that there may be un-discovered food factors in natural foods such as grass, and milk which are of importance in live-stock feeding. Based on the results of a number of natural immunity tests on grazing sheep, Anderson and others suggest the presence of a property in growing grass which has an influence on the defensive mechanism of the animals' tissue."

What is this mysterious property in growing grass, which reacts on the defensive mechanism of the grazing animal, we do not know. A few decades ago we did not know about the vitamins, and civilized people paid by disease and death or their ignorance and disobedience of nature, in running after artificial and dead foods to an exclusive extent. Our knowledge of vitamins has been helpful in regulating our dietary needs to the prescriptions of nature from which men were departing.

This discovery has not been the last work in this direction, and there are other directions about nutrition which are altogether untouched. Therefore, what is quoted in the above extract should be kept in mind, and it would be a saving factor if, even not

knowing the exact requirements, more emphasis is laid on the management of dieting in such a manner that it may, as far as possible, approach the natural condition.

868. Special virtue in grazing : If there is a special virtue in the growing grass, there must be one in grazing also. For the same reasoning, grazing makes available to the animal the earliest growth which grass-cutting cannot do. The grass must grow to some height before it can be cut by a scythe, that is the minimum growth necessary. But in grazing cows can pick up blades still earlier in their formation. It has been the experience of farmers that grazing benefits more than feeding the same grass in stalls. The case of *Khairi* (780) is a standing example. She could not thrive on the ration given to her at the stall of the nutrition expert. She must have been having her share of green grass and the benefit of a balanced and rational meal. But all that could not pick up her condition which did not improve till she was allowed to graze on a good pasture, proving that there is some mysterious, life-giving, disease-resisting property in the growing grass, or as I would put it in grazing grass.

869. Auximones in nutrition : McCarrison in his evidence before the Royal Commission on Agriculture, quoted by Sen (*Agriculture and Live-stock in India. March, 1935.*) said :

“...It has been shown in regard to plants, as in regard to animals, that they cannot thrive, nor their seed attain to the fullest ‘reproductive quality’,

unless they be provided, in addition to the mineral constituents of their food, with certain organic substances known as 'auximones.' These substances which are akin to vitamins are as essential to the normal metabolism of plants as vitamins are to the normal metabolism of men and animals. ..."

It may be that these 'auximone' matters are required by the cow and that they are assimilated best in the process of grazing. Some idea about the auximones will help the understanding of the importance of grasses and grazing in feeding the stock, in as much as they contain these growth-promoting substances in an active state. After the plant-structure is wholly dead these growth-promoting substances naturally cannot remain in their original form.

It has been found from experiments that these growth-promoting substances supply a form of impetus to the plant or excitability to the influences of light etc. These substances have been analysed and three chemical substances have been separated which showed ability to promote growth. The first two of the three have been named 'Auxin A' and 'Auxin B', and the third substance has been found to be a familiar chemical substance, indole acetic acid—which could be made in the laboratory.

Some uses are being made of this newly-found knowledge in horticulture. Cuttings of some plants, treated with these growth-producing substances, showed improvement in the speed of rooting.

870. Auxines A. and B. : These substances modify or control the utilisation of the food-reserves of plants. The auxines have been likened to hormones or exciting bodies in animals. Indole acetic acid is produced by microbial action on proteins, and it is present in urine. The value of composts made out of decaying organic matter is attributed to the presence of these substances. This explains the influence of organic manures in plant growth which cannot be exercised by chemical manures.

This is a vast and fascinating subject, and experimenters have just been able to touch it. More of these growth-promoting substances are likely to be known, and the part they play in the development and growth of plants and animals ascertained.

It has been experimentally found that these growth-promoting substances or auximones send out impetus from the tips of growing shoots as was found in a classical experiment with the hollow tubular shoots of oats just as they came out of the seed.

The special virtue of grazing grass is likely to be, in some way, connected with these growth-producing substances. Without digressing into a subject of intricate scientific interest, enough has been found for our purpose to justify the conclusion that there is something in growing grasses that reacts beneficially on the life-process of grazing animals. Grazing is like breast-feeding. Just as the animal mother feeds the most essential and also complete nutrients from her breast, similarly, it appears, as if mother earth feeds the herbivora with her breast milk in the form

of tips of grasses rich in nutrients and growth-producing auxines. It is remarkable that the auxines inhabit the tips of blades. In grazing, the cow gets the utmost number of tips with every mouthful. Here lies the real reason of the mysterious difference between stall-feeding of cut grass and of grazing. When a tip is bitten off to-day, nature repairs the cut tip which becomes a fresh tip charged with fresh auxines fit for grazing on the next occasion.

871. Changes in nutrients with growth of grass : In this country Lander has conducted a very large number of experiments on the chemical changes that follow the growth of grasses. At different stages the grasses show differing composition. The sum-total of the experimental results is that in grasses the nutritional elements are proportionately highest at the earliest stages. In the earliest stages, however, the quantity of materials available is also very scanty. A mean may be struck when the optimum nutritive material may be obtained in quantity and quality from growing fodders.

It is difficult to compare the grass of one description with another grass. The same grass of one locality differs from that of another locality. Despite these, in the same grasses the variation of mineral-contents with age shows some orderly rise or fall.

It is necessary to have a correct idea of the differences between immature and mature plants. Young plants are watery, containing less of dry matter. Dry matter increases with growth. Immature plants are richer in protein than when the same plants are

made into hay, both being calculated on the dry basis. The immature plants contain more vitamin, more calcium and more phosphorus. Therefore, on all the three scores they are superior to mature plants. The larger content of water in immature grass makes it necessary to be used in larger quantities to get the same extractives. Weight for weight, in a dry condition, the immature plants will show more nutritive value than mature ones. (675)

872. Protein, calcium etc. in growing grass : It may be generally stated that young, immature grasses contain 10 to 15 per cent protein on dry hay basis, while when they are mature or ripe, they contain 4 to 7 per cent only.

As in protein-value so in calcium and phosphorus value also the immature grasses show considerable superiority over their mature state. Calcium varies from .6 per cent at the early to .4 per cent at maturity stage, while phosphorus goes with age or maturity from .4 to .2 per cent or thereabout.

Morrison mentions that dried pasture grass from fertile, closely-grazed pastures supplies 64.7 per cent total digestible nutrient against 51.7 per cent of mixed grass hay of good quality cut at maturity.

Immature grasses are often regarded as concentrates. And they are really so if protein and minerals only are taken into consideration, but if the energy-value is considered, corns and cereals and pulses provide more, and in that respect immature grasses on a dry basis are not equal to concentrates. Yet, even in a comparison between immature and

mature stages, grasses in an immature stage contain more digestible nutrients than mature grasses. But, in total digestible carbohydrate-content, grasses, as has been said, fall short of the grains, meaning that for energy-value grains cannot be replaced by the same weight-equivalent of immature grass, although in protein, calcium and potassium they may stand equal. (612)

873 Grass as a supplier of protein : Here lies a matter of great economic value to cattle-breeding. The cattle here in India may be made to depend upon straws for their supply of energy, and proteins and minerals may be derived for their subsistence from immature grasses when plenty of grazing is available. Even where plenty of grazing is not available, whatever little is available should be assessed at its true value as a supplier of proteins, minerals, vitamins and other growth-producing substances. The abundance of protein in growing, immature grass is a fact of great importance. It should not be forgotten that hays from cultivated, high protein legumes may be equal in protein-content to immature grass. For example, Lucerne-hay contains 16·3 per cent digestible protein and 21·26 per cent total protein. While *Dub* grass (samples from Hissar Grazing Paddock, Cattle Farm—*Table XIV. Lander*) shows for new growth 21·94 per cent and a month later 20·94 per cent of proteins. All *Dub* grasses are not like this, but just as an example, it is shown how rich the new growths may be. Cuttings of the same grass show less protein and there are

variations from cutting to cutting, depending upon soil condition and moisture or rain-fall etc. In Morrison's opinion the best of the immature forages is equal in composition and nutritive value to the protein-rich concentrates, such as wheat-bran, linseed meal etc. The forages, however, even when young, contain more fibrous material than the concentrates, and are, therefore, poorer in energy-value than the concentrates. (612)

874. Cutting of grass keeps up protein value : Pasture grass can be kept high in protein (on a dry basis) by allowing it to continue on the growing stage by frequent cuttings. The protein-content of grasses will remain high during the rains—the season of growth. During the dry season and with the diminished rate of growth the protein-content will be lower at the same state of maturity as compared with the wet season. When the grasses resume their rapid growth, the protein-content also shoots up. When the grass is allowed to head out and to flower and seed, then the protein-content will be relatively low.

What has been said of the grasses does not apply to the cereals and millets such as corn, *jowar*, *bajra*, *ragi*. These plants begin to store large supplies of protein and carbohydrate as they flower and seed out. When both the seeds and stalks are fed, then more nutrition is obtained than if they were fed immature in equal weights on a dry basis.

By frequent cuttings the total yield of dry matter comes to be less than if the grasses were allowed

to grow undisturbed to full maturity. By frequent cuttings smaller leaf surfaces are presented to sun-light and, therefore, there is lesser manufacture of carbohydrates from the air and sun-light and chlorophyll. Close grazing on a crop affects the yields in this way. (612, 675)

875. The reduction of yield by cuttings : It depends upon the nature of the plant and on other factors. The decrease of output in the case of tall-growing plants is more than in the case of low-growing, spreading pasture grasses like *Dub-grass*. It is held generally that grasses, cut at intervals of two or three weeks, will give 50 to 60 per cent of dry matter and 60 to 75 per cent of total digestible nutrients to what they would have given if they were allowed to grow fully and harvested at the usual time of maturity.

The closer the interval of cutting or the closer the grazing, the more reduced will be the yield as compared with what could be obtained by harvesting at maturity. It is, therefore, that rotational grazing is better than continuous close grazing.

The soil also affects the mineral and protein-contents of grasses. On soils, poor in phosphorus or lime, the plants grown are expected to show poor content. From the experiments carried out in India, however, it has not been so far possible to relate the mineral-contents of plants to those of the soil. The subject has to be thoroughly gone into by fodder analysts. Lander had many studies of samples, but clear light has not been coming up to now.

Fertilization with nitrogenous manures increases the nitrogen-content of the grasses. Grass grown partly in shade, as in the woods, produce much less forage, and such forage as is obtained is less palatable to the stock. For making hays, the period of maturity at which a grass is cut makes a good deal of difference in the nutritional factor.

When grass is allowed to mature, there is the normal lowering of nutritional value. In making hays, weathering, exposure to sun or rain, there is again a material lowering of value. The more the hay will be weathered the more will it approach the straws in composition. (675)

876. Dub grass—Cynodon Dactylon : Cynodon is derived from kyon—a dog, odous—tooth or dog's tooth. Dactylon is the Greek Dactylos—finger, alluding to the shape of inflorescence which shoots out in five finger-like lines.

It grows everywhere in India, and in abundance. It flowers throughout the year. It may grow sufficiently tall to be cut as hay, under favourable conditions. It is widely utilised as a lawn grass. Its peculiar habit fits it for the lawn as no other grass does. The more is it pressed and cut, the better and more carpet-like it spreads and grows. It improves by rolling and moving treatments under which other grasses will collapse. The *Dub* is of an aggressive nature and will drive most other grasses out.

It is called Bermuda Grass in America. Seeds of Bermuda grass, imported and grown at the Dacca Farm, proved it to be the same as our *Dub* grass.

Lander observed that it is a highly nutritious fodder grass and one of the best of them. Where conditions permit of being properly grazed upon, it would provide a continuous supply of nutritious fodder. It is a low-growing, creeping grass. It is propagated by planting sods. But the best way of propagating is to take advantage of the rainy season, and allow it to take root from cut-grass stalks.

PLANTING A PASTURE : During the rains the soil is freed from weeds, ploughed under and levelled. After a shower has softened and moistened the surface, tufts of grass are cut in handfuls and planted just as they transplant paddy. The sticking out-tops of these bunches are then beaten down and covered with earth scrapped from the nearest inter-spaces. In this way the sown surface will present a matted appearance. If there is plenty of moisture, or if there is rain, the cut-ends will take root and all the nodes of the pressed-down and earth-covered portions will also take root. In a few weeks, there will be a uniform covering of *Dub* all over the field.

It is an expensive feed if used alone for maintenance. One cow will require one acre to support her. The usual yield of hay is 30 to 100 mds. per acre.

It provides pasturage when closely grazed, otherwise it becomes tough and wiry. If allowed to grow for over a month, the stalks will be like sticks with leaves only at the tops. When the hay

is cropped the ground looks as if it were full of bristles. In a few days leaves appear and the field becomes green and soft. The matter of variation in nutritive materials has been generally discussed. (868-'78) Below are given some analysis results and discussion on them from Lander. (675)

877. Variation of nutritive materials in Dub grass :

TABLE-70
Per cent on dry crop.

		Protein.	Calcium. CaO.	Phosphoric acid. P ₂ O ₅
Young Bangalore	1932	14.68	0.88	0.51
" "	1933	14.83	0.74	0.64
" Pusa	1932	10.76	1.27	0.54
" "	1933	4.46	0.87	0.28
Prime Bangalore	1932	11.89	0.76	0.47
" "	1933	10.24	0.64	0.55
" Pusa	1932	9.18	0.63	0.42
" "	1933	6.29	1.16	0.46
Ripe Bangalore	1932	8.28	0.44	0.30
" "	1933	8.60	0.38	0.25
" Pusa	1932	6.28	0.77	0.39
" "	1933	5.33	0.66	0.50

"A similar series of analyses were carried out in 1933 on *Dub* grass from the lawn adjoining the laboratories at Lyallpur. The first sample was cut in March, soon after the new growth, following the winter cold started, and cuttings were made each

month until the end of October. Here again, the grass was under controlled conditions, the sample for analysis being carefully cut by hand, after which the area from which it was obtained was mowed to uniformity. The lawn received periodic irrigation through the period and was of course subject to the monsoon rains in July, August and September. It will be noted that protein, calcium and phosphoric acid, all remain conspicuously high, although there is some falling off in phosphoric acid towards the hot summer months and at the end of the period when cold ensued." (675)

878. **Analysis of Dub grass at various cuttings :**
The analytical data are as under :

TABLE-71

Lyallpur.		Protein.	Calcium. CaO.	Phosphoric acid. P ₂ O ₅ .
27-3-33	1st cutting	12.75	0.77	0.68
27-4-33	2nd "	9.00	0.77	0.63
27-5-33	3rd "	7.19	0.88	0.69
27-6-33	4th "	7.50	0.98	0.49
27-7-33	5th "	9.50	0.87	0.54
28-8-33	6th "	11.19	0.91	0.67
29-9-33	7th "	11.36	0.95	0.43
30-10-33	8th "	11.48	...	0.57

"In Table, are shown some analyses of *Dub* grass at various stages of growth from the Cattle Farms at Hissar, from Karnal and from Rohtak."

TABLE-72

HISSAR (Grazing Poddock, Cattle Farm).

Date		Protein.	Calcium. CaO.	Phosphoric acid. P ₂ O ₅ .
13-4-33	New growth.	21.94	0.81	0.82
13-5-33	One month older			
	than above	20.94	0.85	0.76
20-10-36	Green Dub (Barani)			
	milk stage	16.25	0.90	0.47

ROHTAK

20-10-26	Bir, milk stage	7.75	0.90	0.81
9-10-26	Agri. Farm.			
	Milk stage	5.18	0.77	0.57

KARNAL

5-10-26	Cattle Farm,			
	Milk stage	10.06	0.64	0.56
17-11-27	Bir. Sounthi,			
	Near Karnal.			
	Ripe stage	4.90	0.50	0.23

“Particular interest attaches to the Hissar figures for young *Dub* grass where the protein figure is as high as from 20 to 22 per cent, and both calcium and phosphoric acid are very satisfactory.

“A sample of *Dub* grass in the early stages of growth from a natural grazing ground at Rohtak, however, shows that calcium and phosphoric acid figures are as high as the Hissar figures. A sample of *Dub* in the milk stage from Karnal showed a

higher protein-content, but lower figures for calcium and phosphoric acid. On the other hand, a sample of ripe *Dub* grass from the Bir at Karnal in 1927 showed a very low-content in protein, calcium and phosphoric acid."

From the above it will follow that there is considerable variation in the composition of *Dub* grass, according to locality, season and the condition of the soil. The soil of naturally-growing *Dub* grass shows the poorest results in all the three items.

If the grass is grazed upon, the droppings and the urine are distributed over the soil, and it improves the quality and quantity of grass. Manuring with a sprinkling of cow-dung before the rains is conducive to keeping the pasture in a sound condition. If, however, the grass is not grazed upon, which would have provided some manure, if only annual cuts are taken, then, naturally, the grass will show poor results in all the nutrients. Something like this was the case with the Bir, near Karnal, from which the naturally-growing grass came for analysis, as shown in the last item of the above Table.

The monthly cuttings of the Lyallpur samples from the College compound showed, however, medium result throughout, and the composition did not very much vary in the monthly cuttings. By the end of the rains, in August, September and October cuttings, the protein-contents were higher than the previous monthly cuttings, except the first one, which was probably due to the first shooting out of blades with

a rich load of protein after the dormant condition of winter. (675)

879. Anjan or Dhaman grass : Kollukkatai grass : It is common in dry soil and is much used in the Punjab, the Bombay and Madras Presidencies. It is common in Africa, Sicily and the Canaries also.

Anjan or Dhaman or Kollukkatai is one of the richest natural pasture-grasses of India. It is very rich in protein and can be very well made into hay. It does not require much rain-fall, the scantiest showers being sufficient for it. And, for this very reason it cannot tolerate heavy rain-fall, such as that of Bengal.

In some of the localities Anjan shows 10 per cent and over of protein. In successive cuttings Anjan showed a steady protein-content of 7 to 8 per cent, whereas there are localities where the protein-content falls to the level of ordinary grasses as at Aurangabad, Meerut, Jubbulpur and Bellary (Madras). From Hosur (Madras) comes a report of an analysis showing as high a protein-content as 20.16 per cent. Bangalore and Poona analyses show protein-content next to Hosur. These analyses would tend to indicate that the plant shows richer protein-content in the south. The Bellary (Madras) analysis is extremely disappointing, giving only 3 per cent protein. But being a single instance it may be suspected that the sample was particularly bad.

Anjan is rich in calcium and phosphoric acid, and these two seem to be well-proportioned. It occupies

most of the natural pasture lands of the Hissar Farm. From the nutritive point of view Anjan is an excellent grass and under proper treatment it is expected to show great improvement.

W. Coldstream (quoted by Lander) observed as under about Anjan :

"It requires a rich land. This is one of the most nutritious grasses and is said to be the very best. It is said to keep good in stack for 14 to 15 years and longer if kept dried. It is one of the first to give way before the plough as it grows on the best lands which were first brought under cultivation. It is now somewhat rare. This grass if in good condition is reported to give a semi-intoxicating quality to the milk of buffaloes which graze on it."

880. Anjan as a concentrate : One experiment was carried out in 1932 to find out its comparative nutritive capacity as a concentrate by T. Murari, Superintendent, Live-stock Research Station, Hosur. Here 10 calves were selected for feeding on Anjan and 10 calves were kept as control. Both lots got 6 to 8 lbs. of milk per day and a 2-hours grazing. The control lot got 1 lb. ground-nut-cake and 1 lb. wheat-bran, while the experimentals got 35 lbs. Anjan dry hay per day. The experimental lot showed in the total greater increase in weight which was 21.6 per cent against the 20 per cent of the control. It was concluded that 1.75 lbs. of hay was equal to one pound of concentrate formed of the mixture of equal parts of ground-nut-cake and wheat-bran.

881. Guinea grass : Guinea grass is a native of tropical Africa, but is now popular in many tropical countries. As an exotic, introduced into India, it is making remarkable progress and has taken very kindly to our climatic and soil conditions. In the plains of Northern India, it remains more or less dormant during the cold weather but flushes up with the spring. In the hotter parts of India, under irrigation, it grows well throughout the year. It grows best during the monsoon and the early part of cold weather. It is propagated generally by roots. Newly-planted roots in bunches of 3 or 4 during May in Bengal will give cuttings in August, if well manured. After 2 or 3 years the plantation is improved if each root-stock is reduced in size by separation. This can be done by the spade: The separated roots will form setts for a new area. In Bengal one plot may be separated out as above and twenty equal plots could be planted with it, all giving splendid cuttings in a few months after the commencement of the monsoons. It needs manure. Provided manure and water are supplied there seems to be no end of the capacity of Guinea grass to yield plentiful monthly cuttings. It cannot stand water logging.

When flower stalks appear, the herbage becomes coarse. They begin to appear after the monsoons. In cutting, care should be taken to crop it as close to the ground as possible. In Pusa no irrigation was required to get an yield of 20,000 to 35,000 lbs. per acre.

With good manuring the yield of 1,000 mds. or 80,000 lbs. per acre has been obtained, which is not an unusual figure.

882. Yield of Guinea grass : Dr. Mann in the Bombay Agricultural Bulletin, "Fodder Crops of Western India," said that at Karachi, under new sewage manuring, Guinea grass yielded a return of eight cuttings of 25,000 lbs. each, totalling 2,00,000 lbs.

At Kirkee attempts were made to find out the maximum yield under heavy manuring. There, in the second and third years, the yields were of 92,000 and 1,51,000 lbs. per acre respectively. The experimenters believed that their yields will break the record. Guinea grass shows a good protein-content. In flower it shows 4.76 per cent protein, and before flowering 7.56 per cent on dry weight. Digestible protein is 3.10 to 5.83.

Raw cow-dung, trenched between rows, does no harm to the plants. These send out rootlets and suck nutrition from the trenched manure. Raw manure can be added to in alternate trenches without disturbing the grass.

It possesses a high nutritive-value and provides a tender and succulent fodder.

883. Napier grass : **Elephant grass :** It is a perennial exotic grass like the Guinea grass. It grows vigorously, specially during the monsoons. It reaches a maximum height of 10 ft. For fodder it should not be allowed to grow to this height but should be cut when about 3 to 3.5 ft. high. It looks

like sugar-cane when mature. Its stems are hard. Its propagation is, like sugar-cane, done through stems cut into setts. For this purpose the plant should be allowed to develop its full height. It can be conveniently propagated by planting sets from parent plants.

It requires like the Guinea grass heavy manuring to yield the best results. During winter its growth is slow.

For planting, the setts are cut into 3 to 4 ft. lengths and put lengthwise in the furrows. Each furrow should be made 4 ft. apart. It is best planted during the monsoon months up to October. 4,000 setts are required per acre. In Bengal, at the Dacca Farm, the yield of the Napier grass was double that of the Guinea grass. But it is much poorer than the Guinea grass in nutritive value. A Pusa analysis showed it to contain only 1.02 per cent crude protein. Another analysis showed 5.35 total and 3.85 digestible protein. It contains .46 per cent lime (CaO) and .80 per cent phosphoric acid, and its potassium-content is as high as 4.8, and is, therefore, unsuitable for rice-areas for use in combination with rice-straw, which itself suffers from an injuriously excessive content of potassium.

The yield of the Napier grass at Coimbatore was 60,000 to 90,000 lbs., about 750 to 825 mds. per acre. At Dacca the yield was $877\frac{1}{2}$ mds. per acre green feed up till the 6th December, and during the same period Guinea grass gave an yield of $467\frac{3}{4}$ mds. At Dacca the Napier grew quicker than the Guinea. The Bengal Government has been distributing setts of

the Napier to cultivators. It is a very drought-resisting and hardy plant.

884. Dryland thin Napier grass : The Deputy Director of Agriculture, Bangalore, in a paper to the "Indian Farming", December 1940, wrote that in their search for a drought-resisting grass they came across a tall thin variety of Napier grass which they have since named dryland thin Napier grass. It was propagated from seeds in 1927.

The seeds are sown in nurseries and the seedlings of about 9 inches height which they attain in 40 to 50 days are transplanted. One pound of grass seed gives enough seedlings to plant an acre. The seedlings are transplanted during the rainy season.

These have done very well in Mysore. They were so drought-resistant that long after the other grasses had dried up, the thin Napier kept its greenness. It grows up to 5 ft. on the poorest land. Three cuttings can be taken in a year, giving about 190 mds. of green fodder per acre. Owing to these cuttings the grass remains tender and furnishes fodder for nearly nine months.

The Agricultural Department of Mysore is trying to popularize this grass for planting the large acreage of cultivable waste, and also the large area of 'gomal' or village common pasture with it. It is prolific, and when the plants seed, seedlings will appear with the rains, so that once planted it will not die, even if uncared for. This grass has grown not only in areas of 18 inches rain-fall but also in areas with 120 inches of rain-fall. The Mysore State harvested 3,000 lbs. of seed for distribution in 1940.

885. Sudan grass : This rain fodder-crop is gaining popularity in Northern India, particularly in the Punjab. It is closely allied to *joar* as its botanical name *Andropogon Sorghum* implies. It is a variety of *joar* with which it crosses freely. It is a sweet, green fodder and makes both good hay and silage. Under irrigation it will yield three to four cuttings, every cutting giving a yield of 16,500 lbs. per acre. It will grow on any soil suitable for *joar*. One of the significant points about it is that it will give a good return of fodder in the shortest possible time. The protein-content of green Sudan grass on dry basis is 4.13 per cent.

Trials made in Honolulu with Napier and Sudan grasses on milch-cows showed that other things being equal, Sudan grass increased milk outturn by 8.66 per cent. It was also found to be more palatable than the Napier grass.

886. Sarson fodder : These are *rabi* crops, giving oil seeds. They can be used as green fodder, and for this purpose the Japanese Sarson variety is the best. It will give two heavy cuttings during the short *rabi* crop period. It grows in any soil, and does not require much cultivation and manure.

887. Water hyacinth : It is not a fodder but a pest of the river courses of Bengal. But men in difficulty with fodder in the annually flooded areas of Bengal have, for sometime past, been using this recently-introduced pest, which is difficult to exterminate and is resisting all organised attempts to do so. It floats on the surface of the water and sends

out roots sucking nutrition from water. As a fodder it has little value. But still it is used along with rice-straw during the rains when nothing else is available.

This plant contains about 90 per cent water and yields ash of which 60 per cent is potash chloride. Its protein-content is from 1 to 2.5 per cent on dry basis. It has a phosphate content of .36 per cent.

In a Dacca feeding experiment with straw and water-hyacinth only, the subjects rapidly lost weight. On the addition of one pound linseed-cake per day, the result was more favourable, the animals gaining weight.

888. **Spear grass** : Pandibellum (Madras), Surwla (Punjab), Sunkhali, Survalu (Bombay), Sukhli, Garyali, Bal Suckeri are other names current in Bombay Presidency.

Spear grass is a natural grass, which in the Punjab prefers damp soil, and in Madras it grows naturally on any soil. The Government Farm at Hosur has a pasture of almost pure Spear grass. When young, the grass is liked by the cattle, but on maturity it becomes rough. Besides, on maturity it develops seeds with sharp barbs which hurts the tongue and makes it difficult to be eaten.

Experiments were made on this grass by Mr. Ramiah, Agricultural Chemist, Coimbatore, which were described in his paper in the "Indian Journal of Veterinary Science & Animal Husbandry", March, 1933; for the determination of the variation of protein and mineral-contents with the age of

the grass. This paper gave a description of the grass also.

"The Spear grass is a very hardy species with a deep-rooted habit, and tillers freely. It is very drought-resistant, and given a normal (South Indian) season of frequent light rain-fall, keeps green throughout the year and provides grazing for animals. The principal period of growth is between September and the beginning of December when the tract receives the bulk of its rain-fall from the north-east monsoon. The flowering period is about the middle of November. At its best the grass grows to a height of 2 ft. and is well-liked by animals. At the time when it is dead, ripe, and seeds have set, the grass is not liked by animals, because of the sharp barbed seeds it carries and which have given the grass its name. These seeds are the one disadvantage of the grass, and the Live-stock Station uses a comb drawn by horses to comb out the seeds before mowing the grass for hay."

The yield of the grass was 700 lbs. of dry hay per acre in 1930, which is considered to be a satisfactory one for the fodder. This particular grass-land was not an intensive pasture, but was only kept free from weeds, and carried a good growth of Spear grass of almost pure culture.

Investigations were carried on for eighteen months, and monthly samples were analysed in four different plots. The average analysis of the constituents of the grass is given below.

889. Spear grass analysis of variation in mineral contents :

TABLE—73

Percentage on dry basis.

1930	Calcium. CaO.	Phosphate. P ₂ O ₅ .	Potash. K ₂ O.	Protein.	Remarks.
January...	0·38	0·393	1·461	4·27	Very dry
February	0·544	0·371	0·842	3·36	„
March ...	0·483	0·242	0·849	3·18	„
April ...	0·733	0·415	1·340	3·52	„
May ...	0·575	0·319	1·399	6·37	Heavy rain
June ...	0·607	0·399	1·512	6·79	
July ...	0·628	0·477	1·379	3·81	
August ...	0·790	0·514	1·163	4·23	
September	0·582	0·347	1·162	5·64	
October	0·402	0·431	1·438	6·39	Heavy rain
November	0·377	0·528	1·395	9·07	In full flower
December	0·420	0·439	1·281	4·84	

It will be observed that the Spear grass has a good supply of protein. But this is really an illusion. It will be seen from the digestibility Table below that its protein is practically indigestible. Only if it is harvested before flowering can a little digestible protein be obtained. The plant marshals its proteins just at flowering, when it is at its highest. The other nutritive factors, calcium and phosphoric acid, show the general characteristics with growth. Phosphoric acid increases with increase of protein, while calcium is affected inversely.

It will also be observed from the Table that after flowering is finished, the analysis figures for protein and phosphorus during the next 3 or 4 dry months, are all very poor. Then again, when there is heavy rain in May, the figures shoot up immediately.

890. Digestible proteins of Spear grass (Sen) :

TABLE—74

Bangalore	Spear grass hay (in flower)	0.89 per cent
"	" (in seed)	0.00 "
Hosur	" —Young	2.93 "
	" —Prime	0.84 "
	" —Ripe	0.00 "
Bombay	... ... Early	2.47 "
	... Before flower	1.86 "
	... (in flower)	0.59 "
	... (in seed)	0.00 "

Spear-grass analysis provides another example of the importance of digestibility experiment. Without an idea of the digestibility one would be tempted to harvest Spear grass when in flower, because at that time the protein-content is 9.07 per cent, the highest during the year. But digestibility trials show that out of the 9.07, only 0.59 per cent is available. (Bombay Report). If the grass is harvested before flowering the digestible protein-content would be 1.85 per cent and it would be higher still, amounting to 2.47 per cent, if it is harvested still earlier.

In a later publication by Mr. Ramiah in the Madras Agricultural Bulletin No. 33 of 1941, the percentage of protein in Spear grass is mentioned as 2.46. (652)

891. **Buffalo grass** : It is a *kharif* crop. The grass is coarse but relished by the cattle. It looks like maize or *joar* in appearance. It has proved itself to be a valuable fodder in Government cattle-farms, but is not very popular.

At Hissar it grows to a height of 10 to 12 feet. Several tillers originate from one root. The yield is 26,000 lbs. of green fodder in a season. It becomes ready in 80 days after seeding. Its growth is slow prior to the monsoon, but during the monsoon it grows very rapidly. It is inferior to *joar* in nutritive value. (Read)

892. **Burkwani—Khavi, Chatyari, Iskir (Bombay)** : It occurs from Morocco through N. Africa, Arabia, Persia, Afghanistan, Baluchistan to the Punjab and Sind. It is a characteristic desert-plant requiring very little water (*Bombay Grasses*—Blatter). It is very common in the Hissar, Bir, Punjab, and in Bikaner. It grows in jungles and not about cultivated fields. It is grazed when tender, but not so when fully-grown. It is stacked and used in times of scarcity. It is a fragrant grass and may impart its perfume to the milk.

893. **Chimbar—Chimbar or Ghantil or Dubra** : It occurs in the Punjab, Sind, Cutch, Khandesh, Deccan. It is a plant fit for sandy soil. It grows in Muzaffargarh and Hissar. It is suitable for all soils, even saline. It is a prostrate grass which sends out runners, and is an abundant and well-known grass, useful both for grazing and hay-making. It takes the place of *Dub* as a fodder grass on sandy soils in the Muzaffargarh district and in the

N.W.F. Province. It is propagated from root stock in spring and in the rainy season.

894. Chamur (Punjab) : Also known as Git, Sera, Male, Shansukha, Gharam, Ghamar, Girni, Mangrur, Barn, Barwari, Barigagli.

Distribution : Arabia, Afghanistan, the Punjab, the Upper Gangetic Plain, W. Peninsula, Ceylon, Australia.

Locality : Punjab, Sind, Cutch, Kathiawar, W. Ghats and Southern Marhatta country—(Blatter).

It is a tall perennial grass. It requires a rich soil and is usually found under bushes where dung has fallen. It is an inferior grass, with a rather bitter and saltish taste. It is grazed sometimes when tender.

895. Lamp grass (Punjab) : *Aristida Depressa* ; *A. Adscensionis*.

Names : Motliburi, Longi Kussal, Lani.

Distribution : In most warm countries.

Locality : N. W. F. Province, the Punjab, Sind, Gujrat, Khandesh, Western Ghats, Deccan, where it grows in most kinds of soil. It is only grazed because it is too short and light to stack, and too fine and soft to be cut with a scythe. It is particularly relished by the cattle and is highly nutritious.

896. Makra grass :

Names : Bombay — Gandhi, Anchi Manchi, Jagar sammi.

Distribution : Throughout tropical and sub-tropical regions.

Locality : The Punjab, Sind, Cutch, W. Ghats. Deccan, Southern Marhatta country. N. Kanara. —(Blatter).

A sporadic grass, growing in the barren places and fields in the drier parts of the Carnatic. It requires good soil. It is a quick-growing grass but not abundant and grows in ploughed and manured lands.

897. Palwan :

Names in Bombay : Changa, Marval, Payen, Palva, Palvan.

Occurrence : From N. W. F. Province, Punjab to Gujrat, Deccan, W. Ghats, South Marhatta country and N. Kanara.

Distribution : More or less throughout India, chiefly in the drier parts ; Ceylon, Afghanistan, Australia, Africa.

It is universally esteemed as a good fodder grass both for grazing and stacking. In Australia also it is highly valued, being regarded as one of the best grasses to stand long droughts, while it will bear any amount of feeding. It is useful also as a winter grass if the weather is not too severe.

In the N. W. F. Province it is considered as nutritious as *Dub* grass.

898. Samak grass : Punjab—Sanwak ; Bombay Presidency—Borur, Pakud, Pacushama, Tor, Todia, Tiria, Sawank. It is found throughout India, Ceylon and all over the tropics. Probably of African and Indian origin. It grows best in firm soils. A quick-growing grass. A very good green forage. Wild Sawank is said to bring cattle to condition and fatten them.

899. Tree leaves as fodder : Mention has been made of the suitability of tree leaves as

fodder (455-'57) in normal times as also in times of scarcity or during floods.

In the Analysis Table (929-'30, 933) the leaves of some U. P., Bombay and Madras trees are listed.

A study of the Tables shows how these leaves are rich in protein, being 10 to 16 per cent. In this matter they are as good as legume hays. Their digestibilities have not been determined. But the avidity with which some of them are eaten by the cows gives promise of a satisfactory digestible protein-content. Their calcium-content is also high, some of them reaching even up to 5 per cent. The phosphorus-content also is not bad.

More attention should be paid to the leaves as regular feeding-materials to the cows. Meanwhile, complete digestibility trials are needed regarding both their protein and mineral-contents.

900. Concentrates : The importance of feeding properly with roughages has been emphasised. But productive work cannot be fully taken out of roughages only. The high quality of roughage is the first necessity, and concentrates must be added to them to give the required production in the shape of milk or draught work or carrying a foetus in pregnancy.

In countries now developed for cattle farming and dairy industries, attempts are being made to grow on the soil of the farm all the roughages and concentrates. In India also it would have been well if this could be done. But the holdings are so divided that it is almost impossible to so arrange that self-sufficient cattle farms and dairies can function.

If the concentrates cannot be grown by the farmer, they have got to be procured by buying or exchange. Concentrates may be classified into :

- (1) Cereal grains, legumes and tubers etc.
- (2) Oil-cakes.
- (3) By-products of farm.
- (4) Animal products.

901. Cereal grains, legumes and tubers : The cereal grains are all rich in starch ; there is only a little fibre ; the digestible total nutrients are supplied in plenty and, therefore, much energy may be obtained out of them. They are highly palatable. Rice, maize, wheat etc. will be taken with relish and the cattle are capable of ingesting more roughages if a quota of these palatable materials is given to them with the roughages.

The cereals are generally low in phosphorus. They have a slightly higher content of it than the hay crops. Some by-products of cereals are rich in phosphorus. Some of their deficiencies may be rectified by legume hays which contain calcium and good protein. But as regards phosphorus, the legume hays also are not well placed.

In India cereal grains are rarely used for cattle feeding. This is obviously for the reason that they supply the human requirements. India had to import rice from Burma to meet her need for this cereal, and even that was barely sufficient for meeting her human needs. Therefore, there is little possibility of its utilisation as cattle-feed for supplying their energy-needs. Indian cattle will have to depend very

largely on the straws and other better roughages for their energy-requirements.

The by-products of cereals are, however, largely used. Some of them are described below.

902. By-products—Turnips, Shalgam : Turnip is a human food and is also cultivated as a fodder. It is a *rabi* crop, and can be taken out in about 8 weeks after sowing. They are chopped and fed to the cattle.

903. Rice-bran : Rice-bran or rice-*kura* was the subject of feeding tests in the Bengal experiments (806) of 1937 by Carbery and Chatterjee. (*Agriculture & Live-stock in India*, 1938). The analysis of foreign hullings showed that about 8.5 per cent bran and 3 per cent polish, in total 11.5 per cent of paddy hulled becomes available. Considering the quantity of paddy produced in India $11\frac{1}{2}$ per cent comes up to a very large figure, indeed. Bran and polishings are mixed together in villages. In paddy-husking in the villages polishing is not done to the extent it is done in mills; therefore, the all-India output may come up to 10 per cent of paddy, which will give an enormous yield in tonnage as cattle-feed. Rice-bran contains a very large amount of vitamin B, and has been recommended for human use in a fresh condition for vitamin deficiency.

904. Oil in rice-bran : Rice-bran has some protein and it is very rich in oil. In the experiments in Bengal, bran showed twenty per cent of oil of a nature which is useful as food.

Rice-bran on analysis was found to contain over 6 per cent of phosphorus (P_2O_5). Of the other

minerals magnesia was found to be 2·6 per cent and lime (CaO) 0·2 per cent only.

The Bengal experiment showed that despite the high promises such a material presented, the results were very unsatisfactory. The animals were given rice-straw and *kura* as feed, but they refused to take their usual quantity of ration. There was a disinclination for the feed. The weights of some six out of the nine animals markedly fell. Although decrease in the in-take of rice-straw would cause a shortage in energy needs, yet the large percentage of oil in the *kura* was likely to keep it nearly at the normal level.

905. **Digestibility trial—rice-bran :** On digestibility tests it was found that about two-thirds to three-fourths of protein passed undigested. As regards phosphorus it was found to be wholly indigestible. Although 10 grams should have been near the maintenance requirement, yet with 43 grams of phosphorus in the feed, there was negative balance or all the phosphorus taken in was thrown out, and something more from the body tissues also.

The experimenters believe that the phosphorus in the *kura* is in the state of phytin which is not readily assimilable. This, along with poor calcium-content and excessive magnesia proved the material to be of little value. It is not mentioned whether the animals experimented upon were accustomed to this concentrate. (652

906. **Limit of using *kura* :** Mr. Gossip experimented by feeding *kura* to the extent of 3 to 3½ seers

in Ferozepur. The result ended in so severe a loss of condition that three animals died.

But 3 or $3\frac{1}{2}$ seers of *kura* would be a very abnormal feed. Experiment on rice-bran so far has given negative results. But there were defects in these experimental feedings. Knowing that rice-bran contains no digestible phosphorus and little lime, if it is fed in small quantities for its protein (digestible over 6 per cent) and oil-content, keeping other items balanced, then the results are likely to be favourable. As a matter of fact, rice-bran is fed to the cattle and the result is not unsatisfactory. Now that the feeding experiment has shown the defects in the digestibility of the phosphorus-content, the poverty of its lime-content has been known also. The remedy now lies in feeding along with rice-bran a due quantity of calcium-phosphate in the shape of bone-meal which will make up for both the calcium and phosphorus deficiencies.

907. Feeding rice-bran with rice-straw : Rice-straw with the addition of the required protein from oil-cake or legume hay and rice-bran and some green grass may form the basis of feeding with the addition of bone-meal. The result is expected to be wholly good. The richness in oil of the *kura* makes it a very valuable concentrate-feed provided its deficiencies are rectified with the addition of bone-meal. In this connection, it is worth while to remember that rice-bran contains an excessive dose of magnesium, and feeding in excess may cause grave injury.

908. Wheat-bran : We have found that wheat-straw (829) is not a suitable food as a roughage, but

not so wheat-bran. It is an excellent concentrate-feeding material. It contains 15 (Bangalore) to 11 (Pusa) per cent protein of which 11·8 and 8·7 per cent respectively are digestible. It contains 1·7 to 3·4 per cent fat. Analysis shows the following figures :

TABLE-75

Wheat Bran.

	Digestible protein.	S. E.	Lime. CaO.	Phosphorus. P ₂ O ₅ .
Bangalore	11·8	56·9	·22	6·23
Pusa	8·7	53·7	·25	1·98

It contains a very high percentage of phosphorus, and on account of high total digestible nutrients, the starch-equivalent is from 53 to 56 lbs.

The protein of wheat-bran is of a considerably better quality than that of wheat flour. The protein, however, is not so well-balanced as the protein of milk. This should be remembered while choosing feeding materials. Proteins from other sources should be mixed so that there will be a chance of rectification. Its phosphorus is one of the richest of all common feeds.

Wheat-bran is one of the most palatable of feeds and has a mild laxative effect. It is very light and bulky.

909. Legumes : pulses : Legume pulses are human food ; these are fed to milch-cows with very satisfactory results in India. As all the pulses are human foods, the cheaper ones are selected for cattle-feeding. Of the pulses *kalai* (urid) is reputed to be the best for increasing the flow of milk. Other pulses are given

to milch-cows, the cheapest being *keshari* (*Lathyrus Sativus*) pulse.

Gram is given to bulls and bullocks for increasing their capacity for work and for keeping them in a proper condition. Legumes, as we know, are rich in protein and calcium and serve to meet these deficiencies

910. The chunies : In the manufacture of *dal* from pulses *chuni* is got as a by-product, and it is largely used as cattle food. It is a leguminous product and is very rich in protein. It is also rich in mineral matters. It tends to increase the flow of milk. Its food-value greatly depends upon the pulse from which the *chuni* is obtained, the way in which the *dal* is manufactured and the presence of foreign matter in it. Very little work on its digestibility has been done. Very roughly it could be said to contain. S. E. 26 and Digestible protein 4·5.

911. By-products—Legume husks : The husks are taken off the pulses, when used for human consumption. These husks of pulses form a very valuable article of fodder. Besides the hulls, these contain fragments of pulses also, which give them additional value. They are palatable and nutritious and serve as concentrates.

Digestibility trial on gram-husk (free from gram dust) shows that though the crude protein-content was 5·99 per cent, nothing of it was digestible ; the digestible protein in percentage was found to be only 0·00. It has a starch equivalent value of 47·0.

No digestibility trial has been made on *araha* husk, the crude protein of which shows 7·04, nearly

the same as that of the whole *araha*r. The mineral-contents of these have not been determined.

912. Oil cakes : Oil-cakes form the most important concentrate feeding-material in India. Oil-cakes are relished by the cattle and a sprinkling of it on the otherwise unpalatable straw makes it palatable. Oil-cake supplies the much-needed proteins and phosphorus in which the dry straw-feeds are so prominently deficient. They go a great way in acting as correctives of roughages. It is usual for almost every cattle-owner to use some one or other of the oil-cakes.

Oil-cakes vary in provinces, according to the character of the oil most produced in the province. Mustard, rape or *toria*-cake, cotton-seed-cake, *til* or gingelly-cake, cocoanut-cake and ground-nut cake are all utilised for cattle-feeding.

For cattle-feeding, cakes from village *ghani* or bullock presses are preferred as they contain a little more of the unexpressed oil which very much increases their value as a feed by raising the energy-value. In fact, working bullocks will be half useful without this helpful protein-energy and phosphorus-providing material.

Now-a-days large quantities of oil seeds are brought to towns and pressed in power *ghanis*. They extract a little more oil and the expressed cakes are passed through expellers, which working at a very high pressure, take out the last traces of oil from the cakes. Such oil-cakes are valuable for use as manure, as the presence of oil is a blemish in manure. But for cattle-feeding they are certainly much poorer, and the

farmers do not go in for expeller cakes for their cattle-feeds. The analysis given of cakes are all for the common pressed-cakes and not for the expeller-cakes or 'extracted' cakes.

913. Cotton-seed cake : Cotton-seed is pressed for oil and what is left is cotton-seed cake. Cotton-seeds are hulled before pressing, while unhulled or entire seeds are also pressed. These whole-seed pressed cakes are called 'whole pressed' cotton-seed cakes. The hulled cotton-seed cakes are known simply as cotton-seed cakes. These cakes contain about 41 per cent protein while the whole-pressed seed-cakes, having the hulls, have a more fibrous composition and the percentage of protein thereby is lowered, coming to 25 to 28 per cent. The cakes are evaluated according to their nitrogen-content.

Cotton-seed cake is one of the richest feeds containing phosphorus ; the 43% protein variety containing 1.2 per cent of it. Oil-cakes generally are poor in calcium, and comparatively speaking, its content of .2 per cent is not bad. Cotton-seed cake like other seed-cakes lacks the vitamins. Vitamin-deficiency should be made up by including green feed, and calcium-deficiency by including legume hays or bone-meal.

Cows fed on cotton-seed give hard milk-fat. Cotton-seed meal contains a substance known as gossypol in appreciable quantities. It has a poisonous effect. But the cattle are immune to it. Care, however, should be taken that too much may not be fed to calves of 3 or 4 months of age. Gossypol

gets destroyed or changed by heat which is used for preparing the seed for the press or the heat generated in the expeller-process. This is of importance in swine-breeding only, for grown-up cattle are not affected by gossypol.

914. By-products—cotton hull: Experiments were conducted in the South Louisiana Institute by Professor J. L. Fletcher (*Agriculture & Live-stock in India*. November, 1934) on the relative value of cotton-seed hull and Bermuda grass hay (*Dub* grass) and other hays. The composition of the stuffs were as under :

TABLE-76

Sample.	Water.	Ash.	Crude protein.	Fibre.	N. Free extract.	Fat.	Digestible protein.	Total Nutrients.
Cotton Seed hulls	7.38	2.8	4.03	53.25	51.84	0.70	0.24	37.34
Bermuda hay I.	4.95	7.20	6.12	40.95	39.83	0.95	3.18	45.68
Grass hay II.	5.45	7.60	8.88	29.25	47.17	1.65	4.62	45.45
Grass hay III.	6.85	7.75	14.38	29.45	39.62	1.95	7.91	53.13

In these experiments milch-cows were fed on all the usual feeds consisting of silage and grains and calcium supplement. Only in addition to these, grass-hay and cotton hulls were fed alternately. One batch of cows was fed dry grass equal in weight to the grains. Their milk-yield was recorded. The same cows were turned over to the next feed consisting of everything as previously, only cotton-seed hulls were given in place of hays, and the results were noted. Three varieties of hays were fed.

The conclusion arrived at was that supplemented with calcium, green feed and protein, cotton-seed hulls were superior to hill-land grass hays but inferior to mixed clover in milk production. In our country an equal weight of hay may be replaced by cotton-seed hulls, being not more than one-fourth of the green-feed.

915. Linseed cake : Linseed cake is a very superior form of protein-supplement for the dairy cattle. It is not only rich in protein but it is very palatable to the stock. Linseed-meal succeeds well as the only protein-supplement for the cattle. It is specially valued for its laxative property. Feeds for milch-cows and calves, containing linseed cake, give more satisfaction than most other concentrates. Linseed-meal as a calf-feed is dealt with in connection with calf rearing. Linseed cake contains 25 per cent of digestible protein, 52 per cent of calcium and 2.2 per cent of phosphorus, making it a concentrate-feed of first class value.

916. Ground-nut or pea-nut oil-cake : These cakes are extremely rich sources of protein. They

contain over 50 per cent of protein, while the digestible crude protein-content is 46·3 per cent. It has 8 per cent fat, ·28 per cent calcium (lime—CaO), 1·28 per cent phosphorus and 76 lbs. starch equivalent.

Ground-nut cake is one of the best protein supplements for stock-feeding. Its protein is of specially high quality and is well-liked by the stock for its palatability. Cotton-seed, linseed and ground-nut cakes are equal in feeding value; linseed-cake is notably superior as a material for calf-feeding. Ground-nut cake is a little laxative, and if not properly expressed and too much fat is left, it may be disadvantageously laxative. In the Virginia experiments it was found superior to cotton-seed meal for milk-production.

917. Coconut cake : Coconut cake has a lower percentage of protein than, for example, ground-nut cake. It has only 21·1 per cent digestible protein; its S. E. value is, however, very high, being 90; its calcium-content is ·5 per cent and phosphorus 1·7 per cent. If there be left some moisture in the copra, the cakes are then apt to get quickly rancid.

Its protein is not of very high quality and it should not be depended upon as the single source of protein in feeding dairy-cattle. This cake contains some oil and it is believed that on account of its peculiar character, the fat-content of the milk of cows, feeding on coconut-cake, rises a little high. That fat-contents of the feeds affect the quality and character of butter-fat, there is no doubt. Not only is the quality changed, but the quantity of fat is claimed to be

increased. Butter from the milk of cows kept on cocoanut cake-feeds is not liked by people.

918. Til cake : *Til*-cake contains 44 per cent crude protein, and 12 per cent fat, and is, therefore, regarded as particularly rich in proteins and fat. It has good keeping quality, and does not readily go rancid. It has given satisfactory results when fed to dairy cows, apparently stimulating the flow of milk. It is said that if fed in excess of the optimum amount, it tends to lower the percentage of the total solids of the milk. (Linton). One to one-and-a-half pounds can be given to a 500 lbs. cow, which will not be exceeding the limit. This cake was at one time very popular in Europe, particularly in France and Germany.

919. Mustard-cake : Rape-seed cake : The composition of this is as under :

Water.	Crude protein.	Fat.	Carbohy.	Fibre.	Ash.
9%	38%	8%	24%	8%	13%

From the analysis it will appear that it is not very different from linseed or other reputed cakes. But as a matter of fact, this cake is not regarded so good a feed as the other cakes, It contains a pungent oil which gives its characteristic flavour to mustard, and which makes it a blistering material. For this very reason its suitability for feeding milch-cows is rendered low. It is not recommended for milch-cows or calves but is given largely to bullocks.

920 Cotton seed : Cotton is an important money crop in British India. About 150 lakhs of acres are

annually put under the crop, nearly 15·4 % of the total cropped area. Its lint is separated from the seed. Enormous quantities of cotton seed are thus made available as a by-product of the cotton industry. In many parts of the world the seed is used as cattle food either dry, soaked or boiled. It is supposed that the seed covers are very hard and fibrous and are difficult to digest. It may be thoroughly crushed before soaking or boiling. Feeding milch cattle on cotton seed tends to increase the hardness of butter which is of great advantage in making *ghee* by the *deshi* method. Morrison observed :

“Animals fed too large amounts of cotton seed may scour badly on account of the large amount of oil. In trials with dairy cows it has required 171 to 206 lbs. of cotton seed to equal 100 lbs. of high grade cotton seed meal”

In parts of north Gujrat, Rajputana, Central India carrots are grown for feeding the animals. They are very valuable for winter feeding. Their water content is very high, being roughly from 80 to 90%. The dry matter is rich in carbohydrates and poor in protein, fibre and mineral matter. The digestibility is very high. They are palatable and rich in vitamins. Carrots when fed to milch cows impart a very good flavour. Generally speaking, they have a laxative effect and aids in stimulating milk production.

921. Molasses : Molasses is a by-product in the manufacture of sugar. It has a very high value, and as a concentrate can replace cereal grains in feeds

to a large extent. It is, however, poor in protein. Analysis shows it to contain :

Soluble carbohydrates	...	70.09	percent
Protein	...	.6	„
Ash	...	4.58	„

There is a prevalent belief that molasses is harmful as a concentrate for cattle-feed. In order to judge the actual effects of feeding molasses, feeding tests were carried on for some time at the Punjab Agricultural College. Two pounds of molasses were daily fed to the cattle and the results were observed. The feeding experiments were made without disturbing the usual food of the cattle as far as possible. It was found that the cattle took 2 lbs. of molasses daily without any reluctance. In case of some of the bullocks, salivation began to appear after feeding for a few days. This stopped on giving them common salt. Blocks of salt were put before the animals, and they licked the salt as they desired.

From these experiments it was concluded that 2 lbs. of molasses could replace 2 lbs. of maize as a concentrate for working bullocks. In case of milch-cows 1 lb. of molasses was used in replacement of 1 lb. of bran. There was no appreciable change in the milk-yields of the cows. Care was taken that in molasses feeding, the other ingredients supplied the necessary protein which was not to be found in the molasses.

922. Winter feeding of molasses : When bullocks were fed over 2 lbs. of molasses the utilisation was not

satisfactory. The trials were conducted on bullocks during January to April (1933), before the hot weather set in.

923. Summer feeding of molasses : During the next summer season similar experiments were conducted to find out the effects of feeding molasses during the summer months, 20th July to 27th September. It was discontinued, because the health of the animals fed on molasses began to deteriorate. Their dung became watery and dark in colour. Some of them went off the feed, while others, when at work, began to breathe quickly during the hotter part of the day. It was concluded that the feeding of molasses during the summer months was not advisable. For affirming the suitability of molasses in the winter, the experiment was repeated in the following winter. The results confirmed the experience of the first winter that 2 lbs. of molasses can replace 2 lbs. of corn in feeding work-bullocks.

924. Animal products : Steamed bone-meal, steamed meat-meal and skimmed-milk are the most used of animal products. Bone-meal is produced by crushing steamed bones and passing them through a $\frac{3}{32}$ inch mesh sieve. The composition has been given in Para 724. It is a highly efficient corrector of feed and can safely be fed to cows and calves in small quantities to correct calcium, phosphorus and protein deficiencies. In the case of wet-area cattle, it is a material indispensably necessary. Meat-meal contains more protein and less calcium and phosphorus than bone-meal. A mixed meat-and-bone-meal is also

available and will form a satisfactory concentrate and will supply the needs for calcium, phosphorus, and protein.

SHELLS : Shells are burnt to obtain lime. In fact, the most superior limes of the market are the shell limes. Shells are collected in a heap and burnt in a kiln, leaving the lime as a residue. The demand for this lime is limited, and all the shells are not utilised in this way. They naturally disintegrate slowly and return to the soil. A better way of utilising the shells is to utilise them for cattle-feeding. Old shells are to be boiled, sun-dried and crushed under *dhenki* or passed through stone grinders. The meal will form an excellent calcium-supplement. In rice-areas where there is dearth of available lime in the usual feeds, it is particularly advisable to collect shells, crush them and feed them to the cattle. They are not as good as bone-meal, for bone-meal supplies both calcium and phosphorus and also some nitrogen, while the shells supply calcium only.

925. Live-weights of dairy cattle from chest girth : For scientific rationing of the cattle, it is necessary to know their weights. Everywhere, in course of the discussion on nutrition, the live-weights came up for consideration. Rationing is based on live-weights. Few individuals can possess large weighing machines for weighing cattle. In the absence of a weighing machine, weights can be found from the following, based upon the chest and girth and body length measurement in inches.

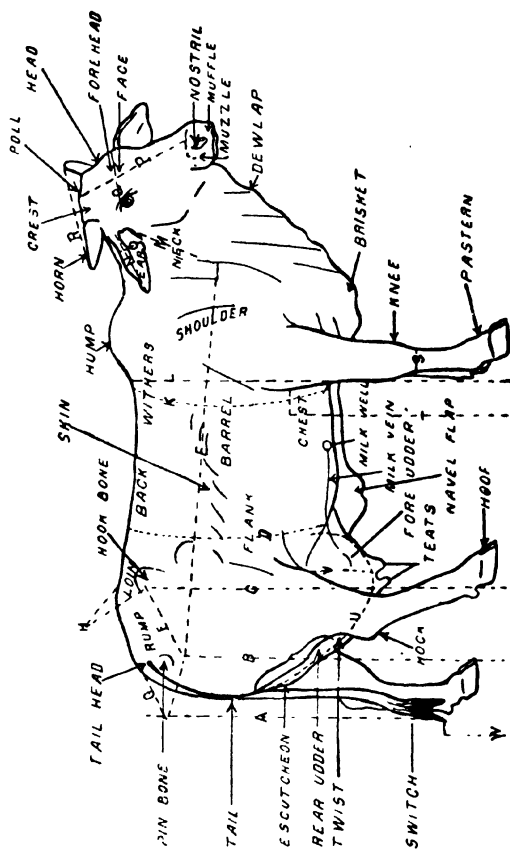


Fig. 45. Measurement of the cow.
(I. C. A. R. Bulletin No. 27)

- A. Length of tail.
- B. Height at pin bone.
- C. Height at hook bone.
- D. Abdominal girth.
- E. Body length.
- F. Length from pin to hook.
- G. Width at pin bones.
- H. Width at hook bones.
- K. Heart girth.
- L. Height behind the hump.
- M. Length of neck.
- N. Length of ear.
- O. Width of ear.
- P. Length of face.
- Q. Width of fore-head.
- R. Width between tip of horns.
- S. Circumference of the shank.
- T. Height at elbow.
- U. Length of the udder.
- V. Width of the udder.
- W. Tip of the tail from the ground.

Sodhi Gambhir Sing of the Punjab Agricultural College has given a formula for finding the live-weights from chest girth and length in inches.

Girth measurement is taken by passing the tape behind the fore-legs. The length is found by measuring in inches the distance from the end of buttock to the protrusion of the shoulder where the fore-legs commence.

$$\frac{\text{Girth in inches} \times \text{Length in inches}}{9 \text{ or } 8.5 \text{ or } 8} = \text{weight in seers.}$$

When the girth is below 65", divide by 9.

„ „ between 65" and 80", divide by 8.5.

„ „ above 80 inches divide by 8.

This formula has been found to tally very nearly with the actual weights of a number of animals, the difference in a large test coming on the average as under :

TABLE—77

Breed.	No. of animals.	Average variation from actual weight. present.
1. Hissar bullocks	84	1.28
2. Montgomery cows	16	1.70
3. Dhanni bullocks	14	1.56
4. All breeds taken	—	—
together	114	1.36

The use of this formula is recommended.
—(*Agriculture & Live-stock in India. March, 1933*).

926. On the use of nutritive value Tables : In using the following Tables, the limitations thereof

should be remembered. It has been made clear in course of the discussion on nutrients, that the nutritive factors differ according to the age of the plant, the locality, and the season in which it is grown. Therefore, a Table which does not mention the locality, the season and the stage of growth is very incomplete.

Of only a few items have the digestibilities been determined. Here proteins mean digestible protein. But the percentages of calcium and phosphorus shown, indicate the total of these minerals but do not give indication of their digestibility.

The digestibility Tables are after Dr. Sen. There are other Tables from the provinces. There the total crude proteins are mentioned and not the digestible proteins.

The analysis of tree fodders, (929-'30, 933) shows how rich they are in all the three items—protein, calcium and phosphorus. The digestibility trials of these are urgently called for.

927. Nutritive value of feeding materials :

TABLE—78

(Adapted from Sen)

Name.	Digestible nutrients per 100 lbs. dry material.			Lime. CaO.	Phos. P ₂ O ₅ .	Pot. K ₂ O.
	Crude protein.	N. R.	S. E.			
	lbs.		lbs.			
Green Feeds.						
<i>Bajra</i>	4.31	12.9	47.6	0.55	0.44	2.96
Berseem	12.56	3.8	43.4	2.69	0.64	3.4
Elephant grass	3.85	13.4	38.4	0.70	0.61	2.99
<i>Guara</i>	6.63	6.4	30.9	3.2	0.38	2.55

Name.	Digestible nutrients per 100 lbs. dry material.			Lime. CaO.	Phos. P ₂ O ₅ .	Pot. K ₂ O.
	Crude protein. lbs.	N.R.	S. E. lbs.			
Guinea grass—						
(young)	5.83	10.2	42.3	0.71	0.90	3.78
<i>Joar</i> (young)	4.20	12.4	35.8	0.69	0.41	2.45
„ prime	3.44	14.7	35.2	0.59	0.32	1.67
„ ripe	1.16	45.0	30.8	0.63	0.25	1.76
Lucerne	16.19	2.7	41.4	3.64	1.12	4.93
Maize	4.68	13.5	52.3	0.73	0.63	1.61
Oats	10.50	5.4	46.6	0.67	0.76	5.28
<i>Senji</i>	12.61	4.1	44.7	1.89	0.42	2.21
Sudan grass	1.57	27.2	28.4	1.19	1.33	1.99
Sun flower	8.55	5.1	37.6	...	...	...
Velvet beans	10.66	4.9	51.1	...	...	...
Hays.						
<i>Anjan</i> hay	1.71	29.3	32.4	0.36	0.72	1.61
Bolarum hay—						
young	2.27	22.0	30.9	0.73	0.24	1.43
„ prime	1.21	42.2	30.6	0.75	0.22	0.90
„ ripe	0.00	...	25.3	0.50	0.09	0.17
<i>Dub</i> hay	8.09	5.7	38.7	0.70	0.44	1.53
Guinea grass hay—						
(before flower)	4.09	10.6	24.8	...	...	...
<i>Joar</i> hay young	2.81	17.3	27.5	0.38	0.54	3.49
„ prime	1.78	27.7	28.4	0.38	0.33	1.67
„ ripe	0.64	79.8	27.0	0.32	0.56	1.9
<i>Kollukkattai</i> —						
young	11.17	4.3	42.1	...	...	...
„ prime	5.49	9.2	35.2	...	...	...
„ ripe	2.97	16.8	33.2	...	...	...

Digestible nutrients
per 100 lbs. dry material.

Name.	Crude protein. lbs.	N.R.	S. E. lbs.	Lime. CaO.	Phos. P ₂ O ₅ .	Pot. K ₂ O.
Oat hay	2.40	25.7	46.9	0.46	0.38	2.44
Spear grass prime.	0.84	52.4	23.2	...	...	...
„ ripe	0.00	...	28.4	...	...	...
„ early	2.47	19.5	30.9	0.47	0.30	1.41
Sugar cane leaves.	0.00	...	24.6	0.55	0.14	1.00

Legume Hays.

Berseem hay	10.29	5.4	47.3	2.07	0.65	3.89
Cow pea hay	10.33	3.9	29.6	2.27	0.40	2.89
Ground-nut hay	14.93	2.3	33.8	2.65	0.58	3.26
Lucerne hay	16.37	2.4	37.7	...	...	...

Straws.

Gram <i>bhoosa</i>	2.41	14.4	11.2	0.47	0.27	2.91
<i>Ragi</i> straw	0.23	243.5	34.7	1.11	0.16	1.5
Rice straw	0.00	...	30.1	0.5	0.15	1.63
Wheat straw	0.00	...	24.3	...	...	...
„ <i>bhoosa</i>	0.00	...	24.5	0.42	0.51	1.25

Concentrate grains.

Barley	7.39	10.6	84.6	0.25	0.85	0.56
Cotton seed	12.49	6.1	85.5	...	...	...
Gram	14.33	4.7	78.5	0.33	0.93	0.72
Oats	7.85	9.0	73.4	0.16	0.93	...
Maize	8.22	10.5	93.3	0.02	0.94	...

Concentrate cakes.

Cocoanuts	21.10	3.3	90.0	0.56	1.69	...
Cotton-seed cake	19.42	3.1	67.1	0.39	2.95	...

Name.	Digestible nutrients per 100 lbs. dry material.					
	Crude protein. lbs.	N. R.	S. E. lbs.	Lime. CaO.	Phos. P ₂ O ₅ .	Pot. K ₂ O.
Ground-nut cake	46·39	0·7	75·9	0·28	1·28	1·43
Linseed cake	25·86	1·8	69·1	0·52	2·20	0·92
Rape cake	30·92	1·8	82·6	...	...	...
Sarson cake	30·68	1·7	78·1	...	...	...
Til cake	42·60	1·0	83·3	...	...	...
Toria cake	28·51	1·8	75·2	...	...	...

By-products.

Gram husk	0·00	...	47·0	...	...	...
Wheat-bran	11·80	5·4	56·9	0·25	1·98	1·46
Rice-bran	6·76	8·5	48·3	0·22	6·23	0·19

928. Nutritive value of some U. P. grasses :*TABLE—79*

	Total Protein.	CaO.	P ₂ O ₅ .
Musel (<i>Iseilem laxum</i>)	5·34	0·35	0·27
Dub (<i>Cynodon dactylon</i>)	9·00	0·85	0·73
Anjan (<i>Pennisetum cenchroides</i>)	2·80	0·32	0·74
Bhanjara (<i>Apluda Aristata</i>)	3·32	0·34	0·24
Sandur (<i>Bothrichloa intermedia</i>)	2·16	0·28	0·17
Kus (<i>Eragrostis cynosuroides</i>)	6·75	...	...
Janewa (<i>Andro pertusus</i>)	6·91	...	...
Jharna (<i>Elesine verticillata</i> or <i>Chloris barbata</i>)	10·82	0·88	1·00
Jhusa (<i>Eragrostis puona</i>)	9·91	0·55	0·87
Cheena (<i>Panicum miliaceum</i>)	12·35	0·57	0·81

929. Nutrition value of some U. P. tree leaves used as fodder :

TABLE-80

	Crude protein.	CaO.	P ₂ O ₅ .
Haldu (<i>adina cordifolia</i>)	15.26	2.41	0.26
Kachnar (<i>Bauhinia variegata</i>)	13.15	3.40	0.04
Mulberry (<i>Moras alba</i>)	13.99	2.74	0.45
Neem (<i>Azadirachta Indica</i>)	15.31	5.53	0.48
Pipal (<i>Ficus religiosa</i>)	12.68	4.58	0.47
Pakur (<i>Ficus infectoria</i>)	10.90	2.92	0.45
Ber (<i>Zizyphus jujuba</i>)	12.8	4.23	0.76
Shisham (<i>Dezbergia sisso</i>)	16.26	4.73	0.54
Pastawuna (<i>Grewia oppositifolia</i>)	16.37	5.00	0.58

930. Some feeding stuffs of Bombay Presidency.

TABLE-81

	Total Crude protein.	CaO.	P ₂ O ₅ .
Mimosa Hamata (leaves)	11.87	4.46	0.24
Lepidagathis cristata	9.25	1.97	0.31
Lantana cama leaves	7.66	2.82	0.23
Cichorium intibus pods	13.30	0.24	0.24
Grewia birgata leaves	11.69	5.31	0.21
Acacia catchu leaves	11.81	4.65	0.19
Randia dumatorium leaves	3.87	3.87	0.09

931. Lesser millet fodders of Madras.

TABLE-82

		Total crude protein.
Tennai-straw	...	3.08
Vargu straw	...	2.187

932. Some grasses of Madras :

TABLE-83

	Protein.	Fat.	Carbohy.
Chengalli Gaddi (<i>Iseilema</i> <i>anthephoroides</i>)	4.26	1.99	43.27
Nanabalu Gaddi (<i>Eremopogon Faveolatus</i>)	3.39	1.66	42.94
Pullirusa Gaddi (<i>Apluda aristata</i>)	4.41	2.52	35.84
Karrapa Gaddi (<i>Chrysopogon</i> <i>orientalis</i>)	4.45	1.13	42.64
Botha Gaddi (<i>Cymbopogon caloratus</i>)	2.27	2.62	44.36
Dabba Gogada (<i>Andropogon</i> Sp)	2.39	2.38	45.70
Nendra (<i>Sehima Nervosum</i>)	2.93	1.47	37.90
Nakka peethu (<i>Perotis Indica</i>)	4.03	1.87	49.41
Gracilia Nutans (<i>Melanocenchris-</i> <i>monica</i>)	4.63	1.37	47.00
Loppopogon (<i>L. Tridentatus</i>)	2.37	1.51	39.58
Chipuru Gaddi (<i>Aristida setacea</i>)	3.32	1.14	43.86
Eteropogon <i>monsotachy</i>	4.33	1.41	44.84
<i>Chloris incompleta</i>	5.48	1.24	45.03
Gogada Gaddi (<i>Chrysopogon</i> <i>montanus</i>)	2.83	1.51	45.37
Poovula Gaddi (<i>Eragrostis bifaria</i>)	2.50	1.77	43.66

933. Some fodder plants of Madras :

TABLE-84

	Protein	Lime CaO.	Phos. P ₂ O ₅ .
Nala mada (<i>Avicennia officinalis</i>)	11.34	0.98	0.42
Cherathela thiga (<i>Derris uliginosa</i>)	16.42	0.84	0.37
Acha or Tepi (<i>Harwickia binata</i>)	10.79	4.10	0.24

934. Average sulphur-content of grasses per 100 parts dry plant :

TABLE—85

Grasses	Total Sulphur.	Total Nitrogen.
Panicum maximum	0·123	1·353
Pennisetum cenchroides	0·196	1·962
Andropogon contortus	0·123	0·870
Andropogon annulatus	0·163	1·157
Andropogon pertusus	0·115	1·117
Sorghum Vulgare	0·137	1·986
Cymbopogon	0·106	1·064
Rhodes grass	0·234	1·774
Elusine corcana	0·405	2·353
Elusine Indica	0·286	1·274
Chloris barbata	0·477	1·704
Cynodon dactylon	0·562	2·228

—(Wrath and Krishnan. *Indian Journal of Veterinary Science & Animal Husbandry*. March, 1937)

THE COW IN INDIA

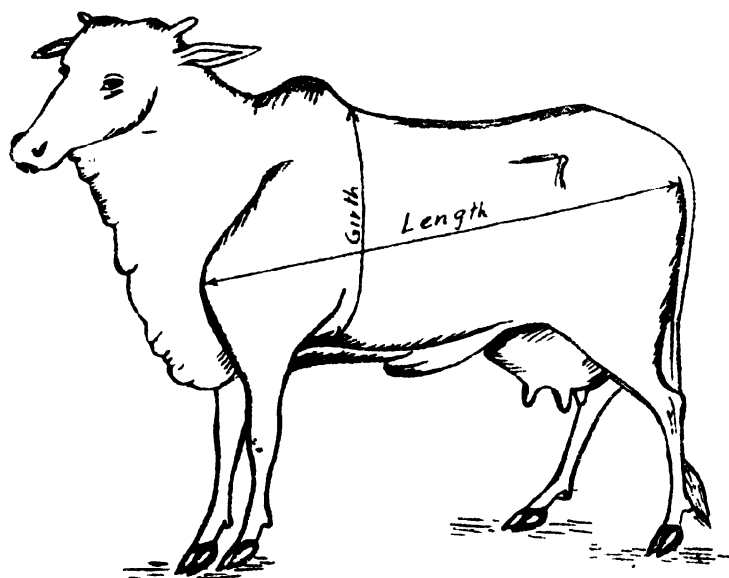


Fig. 46. Sketch showing where to take measurements
for finding weight by the
formula—

Girth in inches \times length in inches.

9 or 8.5 or 8.

(See Page 873)

(Agriculture & Live-Stock in India.. Vol. III, Part II)

The Cow In India

VOL. I

PART-IV

THE DAIRY INDUSTRIES

CHAPTER XXII

MANAGEMENT OF THE COW

935. **Objectives of cow-keeping :** One may start a mixed farm, a farm for cow-keeping, for cultivation, for milk, and for manure-supply, or one may already be the possessor of a herd and a farm. On the other hand, one may simply desire to keep cows for milking for town-supply. This latter aspect cannot be shorn of the association of soil cultivation and manure production. Management has to proceed along lines in conformity with the all-round responsibilities of a cow-keeper. If an enterprise for the supply of milk to towns cares for milk only on grounds of cheap milk production, and allows the cows to be slaughtered, or makes her sterile through ill-treatment, or if the enterprise lets the calves be killed or starved to death, or neglects to properly utilise urine and dung, then such an enterprise should be regarded as anti-national. From this point of view, very few town milk-supplying enterprises will pass the test. The subject of town milk-supply is taken up later on. For the present, the rural condition of mixed farming is only considered.

For a person who has a herd, his problem will be one of making the best out of the herd. It may otherwise be that a new enterprise is started with the profit-motive consistent with the general national welfare. Once a start is made, the position of the

new venture and that of the old owner of an existing herd of cattle may not materially differ. There will be one great difference for the new enterprise in the matter of the selection of the locality and in the selection of the herd, he having a choice which is absent in the case of an old and running farm.

936. The new enterprise: We shall take up the case of the new enterprise. The owner of an established firm may on studying the conditions of the new venture modify his farm-management to bring it as far as possible in line with the new venture.

937. Selection of site: A site should be selected, where agricultural and pasture land are available. A few years' practical experience will tell the enterpriser as to the number of cattle he can keep per acre of land available. It is well to begin with a small unit just as many of our cultivators have, and the new enterpriser must be content with such returns as the older farmers obtain, except for the gain that may accrue to him on account of better farming methods. The aim should be to set up a farm that may serve as a model for improved methods brought to practice. All the fodder and feeding materials ought to be home-grown. But this will be hardly possible. Provision at least should be made for the supply of a definite proportion, say, 20 per cent of the feed as green or silo fodder. Leguminous fodder will have to be provided for. A certain quantity of it should be available throughout the year. Water should be available in plenty from natural sources or from tanks or wells. There are other points

for consideration also. The nearness of a market, transport facilities, availability of labour, should be considered in selecting the site.

938. Selection of herd : If it is a question of buying, the best stock available in the locality should be purchased as a nucleus. Whatever be the ultimate aim of the enterprise, the beginning should be small, and the endeavour should be to create a suitable herd in a few years from the progeny of the nucleus stock. The nucleus should, therefore, be very small, and should be decided according to the ability of the enterpriser to wait for the creation of his minimum unit. In areas where the cattle are very deteriorated, such as the wet-areas of Bengal, Assam, Orissa, part of Bihar and part of the districts of Kistna, Tanjore and Malabar, it will be wise to start with a very small unit. The ground is untrodden from the experimental point of view. Rice-straw and rice-bran have been found to be very inferior fodders. Correctives have been suggested in the Chapters on nutrition (816, 827, 903) for rectifying the inherent unsuitability of rice-straw as a fodder. These suggestions have been worked out and tested satisfactorily in a few cases under my own supervision. Yet, it will be wise to proceed cautiously in such areas and proceed as experience indicates the definite directions.

For other areas, where cattle of recognised breeds exist, pure-type cattle should be chosen so that it will assure an amount of definite result. It has been the experience of many Government dairy farms that purchased stock of well-known breeds, under proper

management, show on the average 60 per cent higher milk-yield in the lactation subsequent to that of their purchase. Cattle from known sources would be best to start with. One will then know what is to be the immediate effect of better management.

Those who already possess a herd have to start with the handicaps imposed by the past. It may not be a handicap after all if the enterpriser will have patience and faith in the newly-acquired knowledge of feeding and management, such as this book seeks to impart. Such an owner will start with the drawbacks he knows. He will start with a knowledge of his herd, and the treatment of each individual which, in proper cattle management, is a great asset. If he has a low-milking type, better feeding may work some improvement. But heredity cannot be ignored. If milk is not there in the strain it cannot be fed into a cow. There the question would be one of improvement of the herd by the use of a better sire, coupled with better feeding and management.

939. Choice of a sire or bull : The sire has to be chosen. If there is no suitable sire in the locality one has to be procured. It is not generally within the means of the owner of a small herd to possess and maintain a sire. At the present moment all over India, the Government Animal Husbandry Departments have been fostering the use of better sires, according to the capacity of the provinces for finding funds for such work. An enterpriser may try to induce the proper authorities to supply a bull on conditions current at the time for any particular

province. Here joint effort is necessary. The enterprising farmer will enlist the co-operation of other farmers like himself and form an association or a *Panchayat* for the improvement of the cow, beginning with the problem of supplying the sire for the village, and for its maintenance. Such an enterpriser will not only help himself but also help the village in carrying out a momentous reform by rousing the villagers to the needs of better breeding. When he secures a bull of the type he needs, his problem will be easy. For definite breed areas such gift or maintained bulls should be of the breed recognised for the area. In areas of non-descript cattle, such a bull should be from a cow of known performance in the locality.

It has been already mentioned that in non-descript areas, the Haryana or similar bulls are being distributed to the peasants. The objection to such a procedure has already been pointed out. If these become failures, they will leave the area worse than what they had found it to be. It would, therefore, be wise to wait rather than go in for a bull imported from some other province into such areas. (506, 512, 796) The appearance of success in the first hybrids is intoxicating and catching. A discriminating enterpriser should appraise such factors at their proper worth.

The Report of the Agricultural Department of Bengal for the year 1940-41 has :

“Now that the scheme for cattle improvement has been in operation for nearly four years in some districts, a number of the female progenies of the

Government bulls have calved and are in milk. During the course of my tours this year I saw many such animals who invariably were reported to be yielding much more milk than their *deshi* dams. Many heifers yielding from 6 to 8 seers milk a day are seen.

"Similarly the male progeny has been observed to develop into a very good bullock. The owners of these progenies are very conscious of their high quality and generally agree to part with them at a price which may be considered fabulous for cattle of Bengal."

This, however, is the report on the first cross at one place. All may not be so well after the second or third or the fourth generation. (165, 506-'12, 796) Therefore, in spite of the tempting results of the use of a superior type bull on a non-descript dam, the enterpriser should do well to wait before he launches into such experiment for reasons explained.

940. Culling : It is the prevalent practice in the Government Farms to eliminate undesirable cattle. Any cow showing declining milk-yield is got rid of. Any heifer not coming up to the expectation is got rid of ; so also about the male progeny. By such a process of elimination a herd may be shown to be rapidly improving in milking performance from year to year. The record may bring credit to the institution, but the effect on the cattle-wealth of the country is of a remote nature. True, a very high-quality strain is cultured in this way at particular centres, and after a time the progeny of the individuals

of such herds may be used with greater certainty for the production of results similar to that of the parent herd. But to accept this view totally would be a mistake, for even in the advanced herds, elimination or culling has to be done every year. Where do they go ? After they have left the parent herd, they may be and generally are used for breeding by the neighbours or others who get attracted by the performance of the parent herd. The rejections of the parent herd are something different from the average of that herd. This change of house, from one farm to another, does not benefit the cattle-wealth of the nation. What the rejections would have done in Herd A, they continue to do in Herd B. The only tangible result is that the parent-stock remains an undiluted high class. Elimination, therefore, does not give a correct picture of the capacity of the herd. And he who takes to farming as a national duty can have little satisfaction with the thought that the inferior cattle have been passed on to others. Under the circumstance, what will the owner of a herd do, when he finds that the performance of an individual is below par ? If it is tolerably good and he is not in need of the animal, he may sell it off after informing the purchaser of the reasons for sale. If it is very inferior in performance, it should not be allowed to procreate ; it should be castrated if it is a male. The castrated male may be sold off as a bullock for whatever it is worth, as no bad consequence can come out of a castrated male.

941. Making inferior cows sterile : The inferior female should not similarly be allowed to procreate.

It is difficult at the present state of veterinary surgical practice to make a cow sterile in villages by the removal of the ovaries or what is technically called 'spaying' in Indian villages. There are dangers of abuse also for making an inferior cow sterile in this way.

The following extract from Black's Veterinary Dictionary (1939) under the heading "Spaying" will point to the danger in it. A spayed cow is being used for prolonging milk supply at the cost of the maternity of the animal preparatory to slaughter.

"Spaying is the term commonly used for the removal of the ovaries in the female. ..."

"Healthy female animals are, in many countries, operated upon for the same reasons as the males are castrated. ..."

"Cows are operated upon to enable them to continue to produce milk for long periods (sometimes for as long as four years) without the disturbances accompanying parturition. They usually give an increased flow of milk which has a better butter-fat-content than previously, and the flow remains practically steady for at least 18 months. In certain city byres where the cows are kept purely for milk-production, and where calves are not wanted, since there is no accommodation for them, the operation, carried out as soon after calving as possible, allows a more uniform supply of milk to be ensured, and at the same time encourages fattening, so that by the time the cow has fallen below the arranged

productive standard (e. g. perhaps 3 gallons per day) she is usually ready for immediate disposal to the butcher. Such commercialisation of dairy cows offers very great advantages over the usual system of only milking the cows during a normal lactation period, and then selling them for beef. The flesh from a spayed cow is more tender and succulent and the carcass more uniformly fattened than ordinary dairy cows. On ranches where there are large numbers of cattle, in North and South America, the females are very commonly spayed to enable them to settle down in the herd more quietly and to fit them to produce better quality beef."

"Operation: The actual operation may be performed in one of two ways; after appropriate preparation, an incision may be made in the left flank, the cleansed hand inserted, the ovaries secured and removed by ecraseur ... With ordinary care, no complications occur. ..."

The *gowalas* of towns keep cows for only one lactation and then hand them over to the butchers. They practise *phooka* on the cow to get milk, a process of blowing air into the uterus. This has to be daily practised at the time of milking. The surgical method of the removal of ovaries is a painless and more scientific way of doing the same thing, with the advantages mentioned in the portion quoted above. In the introduction of the practice of 'spaying' in India, the *gowalas* may find a new inducement for making cows sterile and then butchering. *Phooka* has

been made a criminal offence in Calcutta. Spaying cannot be made an offence, and it may offer more inducement to them for butchering the cows. But this method cannot be supported, as it is ultimately harmful to the cattle, and to society.

942. Separation of inferior cows : A cow, which, it is thought, should not procreate, should be kept separate, and care should be taken to see that she may not approach a bull on heating. If what has been described above on the value of manure and of composting, then a cow, unfit for use as a dam to the future progeny, may be kept on for her dung and such draught labour taken of her as she is capable of rendering. She is used in many districts for the plough or the oil-*ghani*.

It is, therefore, recommended to avoid culling or elimination as a routine practice unless when the enterpriser wants to restrict his herd. Then, of course, the better animals should be sold for the purpose for which they are wanted. The inferior males should be castrated and the inferior females should be trained for the plough.

943. Disposal of the old members of a herd : The herd in a healthy condition procreates and multiplies quickly. The life of a cow is estimated at 18 years, although cases of cows outliving this age are also known. She may bear child up to very near her last days. The progeny of the old cows are not inferior and, therefore, they may be allowed to calve. After 13 or 14 years the intervals between lactations increase. She may be useless a year or two before she

dies naturally. Then again, there is the question of old bullocks and bulls. A bull living beyond its useful age for covering may be castrated and used as a bullock. The problem of the bull is insignificant, as only one bull is there in a herd of 60 cows and as many young cattle. The bullocks get useless with age. What to do with them ? The question of aged cattle that have become useless must come up. Those who have no scruples about slaughter, sell them to the butchers. But humanity calls for a different treatment. The animal that has served you life-long should be treated with kindness, and allowed to live on to the end of its natural span of life. The question of costs comes in. It should be proper to calculate the costing of the maintenance of a herd with allowance for this so-called useless animal. It should be the endeavour of the enterpriser to prove that the cow and her progeny are not useless at any period of their life. They will continue to supply dung and urine in return for the fodder ingested. If properly handled this product will contribute towards their maintenance when they are old and are unable to do any work.

944. Breeder—his own Pinjrapole : It is the preservation of cows and other domestic animals that has given rise to the noble institution of *Pinjrapole*. It may not be convenient for all under town-conditions to maintain old animals, and the owners may be tempted to sell them to the butcher. It is, therefore, that charitable people have established *Pinjrapoles* in or near crowded centres of population.

There are about 800 *Pinjrapoles* all over India. But they can deal with only a fraction of the old and useless cattle of the country. If the old cattle are to be saved the instinct of humane treatment should impel all owners to make provision for maintaining them in their own herds. That the *Pinjrapole* exists is a great and creditable thing for the donors who maintain these institutions. But the owners of cattle who fail to discharge their duty towards their old cattle and send them to the *Pinjrapoles* have nothing creditable to their account. The instinct of pity should, however, instead of blindly operating in us, cause us to make the best use of the old animals. They are bound to pay their way if the value of their excreta and that of the products left after their death are also taken into account. The *Pinjrapoles* could work as models, if they showed that by the utilisation of all the products of the animals, they can pay their own way. The donors and the management of the *Pinjrapoles* owe it to themselves to show the public how to treat their old animals and maintain them most economically. The loss, if any, for maintaining old animals in a herd will work out very low if distributed over the entire working herd. Charity means sacrifice. While charity should be the directing factor in maintaining the old domestic animals, it should also prompt the owner to make the burden of expense as light as possible. The old animals have to be maintained and their maintenance cost is to be included in the total maintenance cost of the herd. For keeping the maintenance cost low, the utmost

use of the manurial products and of the body of the dead animals should be made. That will be the most humane method.

The method of sanitary disposal and economic utilisation of dead animals is described in my book "Dead Animals to Tanned Leather."

945. Relationship with the cow : The cow responds to kind treatment. In fact, she seems to be hungry for a good word, a caress and even a pleasant and approving look. For getting better results from the cow, kindness should be regarded as a very necessary investment. If you are cross with her, she is cross with you, and as a result both suffer.

After having domesticated the cattle, it is but natural and humane that the owner should accord to it and her progeny the same treatment as he accords to his dependents. Here comes in the necessity of refraining from all cruelties and of butchering them. The cows are gracefully slow-going animals. They should not be goaded to move fast. The bullocks also have their graceful pace. Necessity may make men use them for handling carts at high speed. The practice does not fit in with the idea of developing the best in them. They are not meant for speed. In this land of ours speed is not regarded as a matter of first concern. The railways have come and speeded up our travel-rate and lessened space. But we are none the better for it. To a limited extent let speedy vehicles be used. But for routine work in the life of an Indian peasant, speed has little place. His companion is the slow-going bullock.

946. **Why the cow and not the horse :** Why has not the Indian peasant chosen the faster horses as the draught animal ? India can bring up and maintain a fine race of horses. It is a proved fact. Yet, for constant company, for agricultural work, the cow and not the horse has been the animal of choice. In Europe they too have both the horse and the cow just as we have in India. There, they have given the horse or speed the preference. They have kept the cow simply for milk and beef. Why is this difference ? I should suppose that this has come out of the fundamental difference in the culture of the two peoples. Indians wanted to select the animal nearest to him in temperament as a companion. The comradeship that the Indian had extended to the cow would not have been possible if the horse was the animal of his choice. The friendship, the love, the associations that bind man and the cow in India, could not have developed if the choice had been on the horse instead of on the cow. The Indian has kept the horse for speedy transport, for courier and guard and war duties. But he wanted a tamer, quieter, more responsive, and more all-round useful animal to bestow his love and adoration, to sublimate himself. And the Indian has signally succeeded in accomplishing this and in creating a tradition which our modern agricultural economist so dearly regrets and which happily they, with all their ideas of profit and their influence in social status, can never hope to dis-establish. This bond of love and veneration has been wrought through centuries and is too deep

to be changed at the bidding of the theorist. The change is impossible because the relation between man and cow has developed on a feeling of universal oneness. This feeling is to be probed deep to be understood.

Now, having chosen the cow out of the two animals, the cow and the horse, it would not do to ask the cow and her progeny to do the work of a horse. I have rode on carts drawn by very fast-going bullocks. I have admired the speed. I think I covered 8 miles in an hour over undulating ground and back again in another hour after about 2 hours interval, a performance equal to that in a horse-drawn cart. But I have inwardly felt sick despite the physical comfort of cushioned seat and the exhilaration that speed brings. Now, I find the reason of it, as I write this. The bullock is not meant for fast drive, its constitution is against it. Let it live on and drive India slowly to her goal. The slow speed of the cow and bullock is grace itself. If you have a pregnant daughter or daughter-in-law you bless her in her slow, graceful movements. The cow is that daughter or daughter-in-law, whether she is pregnant or dry. Slow movement is their own and is their grace. If you want to bring the best out of your cow or her progeny do not goad them to speed.

947. Give names to cows: The cows and her progeny should be given names of rivers, names of flowers, names we give to our sons and daughters. They love to be called by their names. Even the little calves understand the call by names. In a

place 150 cows happen to be milked in the open while their calves are penned. At the milking-time the name of the cow is called out and she arrives at the appointed place by herself. The same call brings her calf to the door of the pen to be opened out by the attendant. This happens unfailingly day after day with all the cows and their calves. If you have a cow to bestow love on and if you call her by her name, when she is far away but within hearing distance, she will run to you in a hurry as if enquiring, "what has happened? Why do you want me? I am here." If you throw her a smile, a pat, her anxiety goes. She becomes satisfied and returns to her place. When a cow or a bullock is after something wrong, shout at the animal and it will understand that it is attempting something which is prohibited, and at once it will correct itself. Where then is the need of the goads in dealing with such an animal?

948. Not goads but combs : Mr. Wynne Sayer, writing about herd management, said that in his Pusa Dairy, goads or sticks were not allowed. Men were given combs instead. While the cows or calves were grazing, the duty of the attendant was to comb and dress their skin, rub off dirt or take out chance ticks, or brambles. A cow may be vicious, may try to attack you, and that quite unreasonably, but the secret of conquest is not to mind the viciousness but to continue showing kindness. She will be tame in time. Love will conquer her.

949 Love the cow : By close association with men, their feelings have become mysteriously refined.

I cannot reason it out, but the reaction is clearly noticeable. In the Alipur Jail, one of the cows in the herd that I was looking after, lost her calf in an epidemic known as Black Quarter or Blackleg. The cow, Botu was her name, became disconsolate. She went on weeping and refused food. For a week she kept off from her feed, all the time shedding tears. So much was the flow of tears that her eyes got affected. It took a long time to bring her back to normal, and I do not think that she will be quite herself again till her next calving.

Once in the same herd, a cow had a prolapse of anus. She had to be cast on the yard and treated. She was in great pain all the night. It was a bright moon-lit night and the yard was visible from the shed where the milch cows were kept. The next morning at milking-time every one gave less milk showing how the sight of pain had reacted upon the whole lot of milch cows.

There was a little female calf 'Mira'. She got an injury on her fore-leg when she was barely five weeks old. There was septic fever. She survived the fever but the injury and dislocation remained. The bone could not be set because of the swelling. The swelling showed signs of suppuration and I opened it with a lancet. The next day as she was being brought to me she understood what was going to happen and she began to weep. Tears rolled down her cheeks before she was touched at all. This was just what a child would do at the sight of a surgeon who had operated on it.

The cows deserve your kindness. If they are unruly and unreasonable at times, do not get angry. Your anger will do no good ; on the contrary, will make things worse. It may be that by the use of force and by beating you get what you want to be done, but you do so at the risk of considerate conduct from your animals. There are some who will be more vicious the more cruel you are to them, and you can never make them do your will by beating and awarding other punishments. Punishment, even rebuke, is to be given up if you want to own a decent herd. Mr. Wynne Sayer went so far as to observe that there was no future for a cow which required to be led to your presence by two persons holding ropes. This behaviour was partly the result of bad management. Heredity also plays a part. This should be cured by uniform kind handling.

Cow-keepers all over the world, in England and America, in Denmark and elsewhere on the continent of Europe, are unanimous in insisting upon according kind treatment to the cow.

950. Housing the herd : Adequate space must be allotted for housing the herd, if the creation of an economic unit be the aim. For mere milk-production, townspeople may think a stable to be enough ; the scavengers to take away the manure ; straw and fodder to be purchased from day to day ; so space to accommodate the cow and her calf would appear to be enough. But this is not cow-keeping. It is cow-killing. The calf will soon be rickety for want of exercise, and if it dies the caretaker will have a part

of the skin stuffed to be presented to the cow for letting down milk. The cow will also follow the calf after spending her milking period in the owner's stable, for another unfortunate one has to be brought in there and the previous one must die to make room for the new-comer. This is not cow-keeping. The subject of cow-keeping for town milk supply is separately dealt with in another Chapter. It is mentioned here to show how not to attempt to think of the cow without providing for her use in her triple capacity as progenitor of the bullocks and of the dams of the future, as the giver of milk, and as the producer of manure which gives life to the soil to enable the soil to maintain both cows and men through the plants and plant-products. The cycle (see *introductory*) has to be repeated. Therefore, at the very outset of any cow-keeping endeavour all the three aspects of her functioning should be provided for. The herd will require more living space if it is to be managed on improved ideas.

There should be sheds for housing with troughs for feeding. There should be some ground for exercise by the calves and for the milch cows, and there should be some pasture for grazing, although it would be almost impossible to provide the requisite pastures in the near future; and lastly, there should be provision for handling manure and converting them into composts.

When the herd is a fairly large one, say, 20 heads of cattle with 4 or 5 cows, the calves and the bullocks should be housed and fed separately, while

in a small concern a pair of bullocks, one or two calves and a cow may be housed under a single roof. The feeding and tying-place of milch and dry cows should be separate as their feeds are different. Similarly, separate arrangements should be made for the bullocks and the calves. For the calves again, when there are several of them, they should be penned and fed separately according to age. Calves from the new-born to two months age may be kept together. Those from above two months to six months should be kept together, and above six months to a year and a half will form another batch, and then the older ones up to maturity will form a batch. When they will be either heifers or bullocks they will enter separate batches meant for them.

If the calves are thus separated then they may be fed in common troughs. When the smaller ones are kept with the bigger ones, the latter punish, trample and knock about the former and prevent them from eating their quota. If no separate housing arrangement can be made for a very small herd, then each calf will have to be kept separately, tied and fed from separate troughs to which its neighbours may not have access.

Even when the calves are separated it would be a good practice to let each one feed from separate troughs without disturbing its neighbour. When the growing calves are kept separately, according to age, it is a sight to see them feeding, playing or grazing.

951. The cow-shed : For rural establishments it is convenient to have a central row of feeding

troughs in the shed, the animals being tied opposite to and facing one another. There should preferably be two rows of troughs. Earthen vessels will serve both for feeding and watering. The watering troughs may be common between the two rows of animals. Between the animals and the wall there should be 2 to 3 feet of space, allowing for the attendants to move about, and for accommodation of the drain for carrying off the urine.

The feeding and watering troughs are placed on a raised platform—the troughs to be $2\frac{1}{2}$ feet from the floor for adult animals. Spacing of the animals should be such that each one may lie down conveniently without interfering with the next ones. For smaller-sized animals about 4 feet of space would be required. They should be tied to rings or posts against the platform so close that more than allowable movement may not take place. A stout piece of bamboo fixed along the length of the troughs with slip-in nooses at proper distances is a convenient method of tying. The bamboo is kept fast at several points.

The floor should be of earth. *Pucca* or cemented floors are convenient for cleaning. For rural herds it will not be possible. A poor peasant cannot have *pucca* and cemented floors. But even where the owner can afford to have *pucca* or cemented floors, it would be better to have *kutchha* floors for the sake of the health of the animals and for the better use of manure.

In very wet places during monsoons, when nothing dries up quickly, the *kutchha* floor may become soft

with urine and end in becoming 'clayey. This should be prevented by having a layer of sandy loam for the topping. The top is designed for occasional removal and replacement with a fresh layer of earth. (472-'73) This entails labour, but this labour has to be spent both for the health of the animals and for the sake of preserving the manure.

The floor should slope towards a drain leading to a covered pit. In the pit should be an earthen-ware vessel to receive the drainage. There may be four such on either side of each row of animals, and the slope of the floor and drain may be adjusted to this requirement.

There may be a low-height mat-wall a few inches above the floor level all round the shed. This may come up to a height of two feet. There should be a three-feet gap and, above that the top-piece of wall matting may be fixed. The three-feet clear space may be protected with bamboo *tatti* or gunny screens for protection from rain or from cold during very cold weather. Usually the cows bear well the cold. They feel discomfort with rain, particularly when rain falls incessantly. Out-door life for 24 hours in sun and in light rains, summer and winter, is not harmful to the adults. The milch-cows need housing as they are very susceptible to changes of weather.

In Bengal, when cows are kept in an enclosed yard where there is a shade tree, with an open shed for shelter, even during winter the cows prefer to stay in the open, keeping the shelter vacant. It is only when rain disturbs them that they take shelter under

the shed. They can tolerate light rains but get distressed in heavy rains and must have protection.

The method of renewal of floor and of using the urine and dung is described in Paras 468-'72. Provision has in the alternative been indicated for using the dung by itself on maturing. But this would certainly be a wasteful process, and would be discouraged in favour of composting.

952. Accessory shed : Next to the housing-sheds, there should be two sets of sheds, one for composting and preserving the compost, and another for storing dry earth so necessary for the cattle-shed. In fact, full utilisation of the manure from the cattle cannot be made if dry earth is not kept available throughout the year. This requires a shed. Mere heaped-up earth in the open will not do, as the heap will soak through during the rains, making the earth unfit for use in absorption.

The floor of the cow-shed should be spread with a layer of waste material for use as litter for providing bed as also for absorbing urine for the conversion of the litter into compost. A collection of dry leafy material, waste straw and stumps should be kept available for this littering. There should be addition of green leafy matter day to day for composting. But a stock of dry litter should be preserved after each harvest for supplying litter up to the next one.

Theoretically cattle urine and dung are valued at Rs. 1/8/- per month per animal of the herd. If there is a herd of twenty heads, the monthly income from urine and dung, according to this estimate, is Rs. 30/-.

When rendered into composts the value increases three-fold, inclusive of the composting material, and the magic that this compost does to the crop has been mentioned in the *Introductory*. The utmost consideration should, therefore, be given to the collection and the preservation of manure at every stage during the day, wherever and in whichever way the cattle may be kept. When they graze, they make the manurial contribution to the pasture. But the manure should not be allowed to be left there, it would be better to arrange for composting the dung for the common ground through common effort and for returning the layer of composted manure to the grazing ground. When the cattle walk to and from the pasture, devices should be made for collecting both urine and dung. It is no good letting the cow urinate on the path and allowing the urine to be wasted and the path to be soiled. Vessels hung on the backs of one or two animals, trained for the purpose, may easily do it. They may be held in place for receiving urine by making the animal stand as it urinates. Dung can be collected as they pass along.

953. Cattle in the open : Sir Arthur Howard gives an illustration of how a farmer in Great Britain profited by minimising stall-expenses and keeping the cattle in the open for the sake of curtailing the cost during a slump, and how his retrenchment-effort brought much more than the calculated saving in the shape of higher returns from the pastures :

“The most spectacular example of humus manufacture in the soil underneath a pasture is that to

be seen on Mr. Hosier's land on the downs near Marlborough. By a stroke of the pen, as it were, he abolished the farm-yard, the cow-shed and the dung-cart in order to counter the fall in prices which followed the Great War. He re-acted to adversity in the correct manner; he found it a valuable stimulant in breaking new ground. The cows were fed and made to live out of doors. They were milked in movable bails.* Their urine and dung were systematically distributed at little cost over these derelict pastures. The vegetable residues of the herbage came in contact with urine, dung, air, water and bases (*alkalies*). The stage was set for the Indore process. Mr. Hosier's invisible labour force came into action: the micro-organisms in the soil manufactured a sheet of humus all over the downs: the earth-worms distributed it. The roots of the grasses and clovers were soon geared up with this humus by means of the mycorrhizal association. The herbage improved; the stock-carrying capacity of the fields went up by leaps and bounds. Soil-fertility accumulated; every five years or so it was cashed in by two or three straw-crops; another period under grass followed, and so on. Incidentally, the health of the animals also benefited; the prognostications of the neighbourhood (when this audacious innovation started) that the cows and heifers would soon perish through tuberculosis and other diseases have not been fulfilled."

—(Howard. *An Agricultural Testament*—P. 99-100).

*Bails are herd-rests for cows during milking.

We have little pastures in India to copy this example. But where they are, the experiment of keeping the animals all the 24 hours in the open for the benefit of the pastures and for minimising the cost of care-taking involved in stall-feeding would be worth-while trying.

In east Bengal there is the practice of keeping the cows in the fields in shades during the dry season. The object is the enrichment of the soil by manure. The light structure used as shed is shifted from field to field from month to month. During the rains, and when the fields are uninhabitable, the herd is brought home. The peasant is rewarded with a bumper crop in the neighbourhood of the sites of the cow-shed. They distribute the daily yield of manure by occasional ploughing in of the surrounding soil after spreading the dung. The urine gets absorbed in the soil which, on the removal of the shed, is spread out.

954. Mosquitoes and fleas : Mosquitoes and fleas annoy the cows. Some of them are blood-suckers. They bite and suck blood and occasionally impart disease through their bites. We shall know more about this class when dealing with cattle diseases. Mosquitoes and fleas should be prevented from annoying the cows. They are pests of the cattle, and do considerable mischief. For mosquitoes, the chief remedy is to smoke the place. In some places it is a common practice to let some wet straw moulder and emit smoke. Mosquitoes and fleas cannot tolerate smoke and they leave the site. Well-regulated and controlled smoking will go a great way in warding

off these pests. Wet *neem*-leaves if used for smoking in a smouldering heap is particularly effective in driving off mosquitoes and fleas.

955. Poison and poisoning : When the herd is out in the field, the attendant should be watchful and see that harmful material is not eaten by the cows. There are several species of poison-plants, and local people know them. These should be avoided.

Another source of danger to herds in pasture is from professional poisoners. There are a class of people whose profession it is to poison cattle for their hides. Arsenic poison mixed with sweets are left on pastures or put inside plantains, and are offered to cows when opportunity occurs. The herd should be guarded against such dangers.

956. Prevention of injuries : Cattle in herds sometimes fight amongst one another. Occasionally severe injuries result. For better control of cows some Government farms in India dehorn the calves soon after their birth so that horns may not grow. In cases of cattle who are persistent in the habit of fighting and wounding others, the tips of horns may be cut and rounded off, wooden balls may be put on the tips without cutting them. This is also quite an efficient method.

957. Hump sores : Hump sores are often started by the pecking of crows. Once started they are difficult to heal. They badly disfigure many animals. These sores are irritating and spread gradually. Pecking by crows has to be prevented. The sore

heals up slowly by the application of the following ointment :

Litharge (*Mudra Sankh*)—1 part by weight.

Tobacco leaves powdered—1 „ „ „

The two, finely powdered and sifted, are mixed together and incorporated in a bland oil like cocoanut oil, to give it the consistency of a paste.

The sore is cleaned by the application of tamarind made into paste and kept thereon over-night. Next day the ointment is applied on the clean sore. If the sore is not sufficiently cleaned by one application of tamarind, several applications, one after another, on successive days have to be made. The litharge-tobacco ointment is to be smeared over the wound daily or on alternate days if the thin layer remains intact up to the next day. The application is to be continued. The wound heals up slowly in course of one or two months but may require more time if fresh pecking by crows is not prevented. Gradually a scar only is left, which in course of time takes on hair and the skin then presents a completely healed surface. It may take a year to come back to normal appearance.

958. **Ticks :** Ticks are sources of great annoyance to the cattle. Particular areas have particular forms of ticks. The ticks may be combed off. They also manage to live on the floor of the shed or on fields or on the walls of sheds, and attack the cattle when convenient. It is difficult to get rid of them from those sites. Insecticides are helpful. Tobacco is a very good and inexpensive insecticide. Tobacco,

powdered and sifted, is to be placed in a tin vessel and kerosene oil added to it. 6 oz. of tobacco to a gallon of kerosene oil is a good proportion. The mixture is heated for several hours in a water bath with occasional shaking. Kerosene, by this treatment, extracts and keeps dissolved in it the nicotine of the tobacco. This kerosene extract is to be sprayed over the body of the animal. For spraying, the mixture should be allowed to settle, and the clear filtered liquid used. The skin of the animal, particularly the affected parts, should receive the fluid. The ticks do not die immediately and no result or change is observable immediately. Next day the ticks are found dead while still gripping the skin. The dead ones may be easily combed off.

When the floor is infested it has to be turned up and sent to the compost heap and a new floor laid. When this is not temporarily possible, straw may be scattered over the floor and fired under control. The heat of the fire kills those on the surface of the floor, also those that may have taken shelter by grubbing under the floor. Precaution is to be taken so that fire may not spread on to the structure. The treatment of the floor should be taken up after removing the cattle from the shed.

The pastures and grounds should be observed and the tick-infested ones are to be avoided, and if it is farm property it may be ploughed up and some crop grown to get rid of the pest.

959. Cattle dipping : The eradication of ticks can be effectively taken up by the stock-breeders

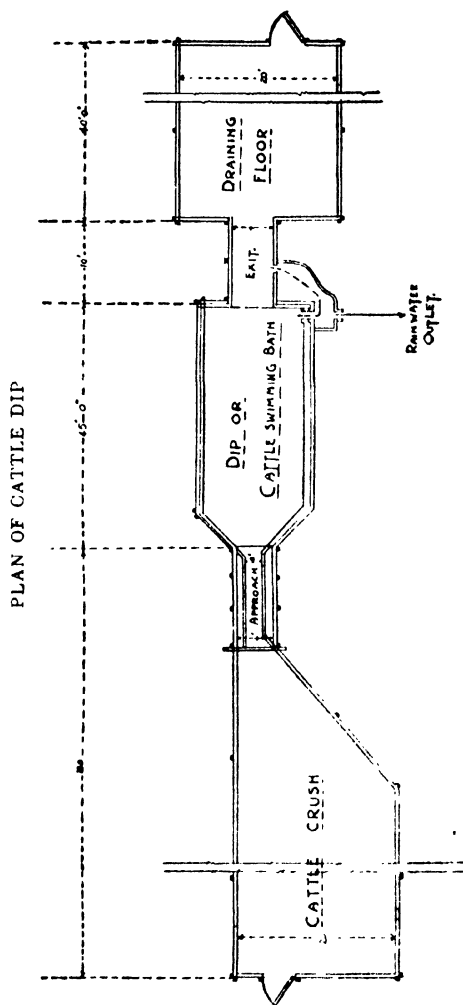


Fig. 47. Plan of the cattle dip.
(Agriculture & Live-stock in India., Vol. VIII, Part I.)

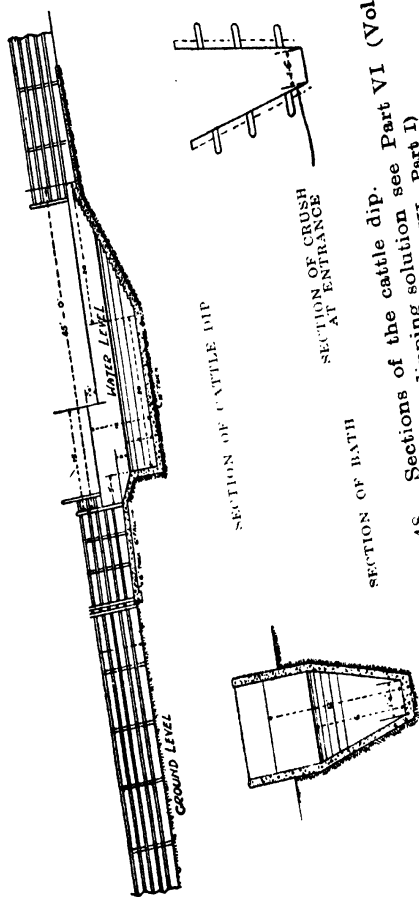


Fig. 48. Sections of the cattle dip.

For details about preparation of cattle dipping solution see Part VI (Vol. II).

(Agriculture & Live-stock in India., Vol. VIII, Part I)

on co-operative basis. By dipping, it is aimed to keep the ticks attached to the body of the animals, immersed for a few seconds in a poisonous solution as they swim through the dip.

"The dipping tank or vat as designed (Fig. 47 and 48) consists of three sections ; (1) the approach, (2) the dipping vat and (3) the exit or draining floor. ...The approach is protected on the sides by railings with a floor space just enough for one animal to pass, which prevents its backing at the sight of water. The vat is constructed to the requirements of the kind of stock to be handled. The entrance slopes down to a sudden drop which helps a complete dipping of the animal as it is compelled to jump from the walk end. The animal then has to swim a length of about forty feet through the dip, which has an exit with steps for the animal to walk out conveniently. The draining floor, where the animals are again collected for draining off before they are let out, is sloped in such a way that all drippings are returned to the tank to prevent wastage of the chemical." (*Agriculture & Live-stock in India. January, 1938*).

960. Cleaning : Cows love to see their skin well kept and detest the touch of urine and dung as much as men do. But they do not know as dogs and cats do how to take such precaution that excreta may not foul their body. The management should see to it that there is the least chance of their skin-coat getting contaminated with urine and dung. When the body is soiled, it should be washed clean, and

where there is scarcity of wash-water they may be dry-cleaned by rubbing with straw. Washing, however, is the best procedure. The stall-fed cows should receive a daily wash. Where there is a neighbouring stream they may be taken there and scoured and rubbed clean in flowing water. Where labour is plentiful, they may be washed standing on a piece of cemented floor, while tied to a post. Washing even in the cold days of winter does no harm. In the cold weather care should be taken about giving baths. Some cows, calves generally, do not tolerate baths in cold winter days.

961. Trimming : The hoofs and horns are to be kept clean. Occasionally the hoofs require trimming. The hoofs should be examined, and if they taper out, be trimmed down to the normal. The method is the same which the professional men employ for shoeing an animal.

962. Slippery floors : Slippery ground or floor is to be avoided. Cases are known where bad slipping results in death or dislocation or fracture. The heavier the animal, the greater should be the care taken not to risk slippery floors or paths.

963. Paths, gates, fencings : The herd should not be rushed through the paths under any circumstance, particularly through narrow gates. If there is a gate to the enclosure or the shed itself, it should be sufficiently high. A low fencing wall or gate tempts the more turbulent animals to attempt to jump off. Fatal injury may come this way. The gates and fencings must not have pointed ends to prevent

escape. These may get stuck on to the stomach in an attempt to scale and rip open the bowels with fatal consequences. Barbed wire fencing should be strictly avoided.

964. Securing the bull : The bull, if kept in a herd, should be sufficiently secured with a nose-ring. A bull without a nose-ring is an untractable animal. Occasionally the most quiet bull takes a fancy to goring the attendant or the owner. When approaching a bull this fact should be remembered. Familiarity may make one forget the precaution, and the result may be a serious injury and may even be fatal. The bull has such great reserve of strength that it is nothing to him to squeeze (1049) a man flat against a wall or against a fencing or even against the floor.

965. Exercise for the animals : The calves after milking should be allowed to frolic about. They jump and run for health and vigour. It is a cruelty to keep them always tied up or to keep them cooped up the whole time in narrow-spaced enclosures where they cannot run about and play. They must be given some time daily when they may run about as they please. The calves need more playing even than our children do. Cows and bulls also should be exercised ; cows require treatment separate from the bulls. They should be made to do some work or should be driven about at some speed. The cows should be made to walk slowly in any enclosure if they are stall-fed and not sent to pastures. The cattle of all ages need proper exercise,

and this should be ensured to them according to circumstances.

966. Smooth halters : The fastening ropes should be smooth. The rope round the neck should be thin and smooth. Several of them may be used together to give strength. They should be kept sufficiently loose. In order that the force of the pull of the body on the rope round the neck may be broken in, a second piece of thick rope, preferably a thick type, should connect the neck collar by passing as a loop over the face. This will have the effect of pulling down the head when force is applied on the tying rope. Some cows have the bad habit of chewing the tether and breaking loose. Slender pieces of bamboo jointed with ropes may be used successfully like a chain.

967. Regularity : Regular time should be observed in all matters in attending to the cow. The time to open them out in the morning, the time for cleaning, for feeding, and the milking-time must be the same every day. They get annoyed and fret when this routine is not observed. For working the bullocks, the hours of work should, as far as possible, be arranged with regularity, so that they may know when to get ready for work and when to leave off work.

They cannot speak, but they do protest and exhibit their annoyance and intolerance. In order to get the best out of them, the time-table should, as far as possible, be rigidly maintained from day to day.

968. Health : Watch should be kept on the health of the cattle. If there is any illness, the first

symptom probably is their refusal of food. The cause should be at once determined and remedial measures taken. The general condition of health should be observed. For this purpose the girth measurement should be taken every month and the weight found out according to schedule. (925) The growing ones should put on the requisite weight, and the developed ones should keep up proper weight. For growing cattle a weekly measurement is a necessity up to 2 years of age. For the grown-up ones a monthly or 6 monthly check would be enough.

969. Tattooing—Branding : For large herds there should be some method of identifying the animals. Where there are old attendants who know the cows, there is no difficulty with the grown-up ones. But calves are easily mistaken and even old attendants will sometimes fail correctly to identify a weaned calf. So long as the calves are not weaned there is no difficulty. Once they are weaned, the association with the mother is lost. They change their features rapidly with growth, and identification becomes more and more difficult. With the change of old attendants identification is lost. It is necessary, therefore, to have some permanent method of identification, some permanent mark on the body of the calf or cow.

A common method for large farms is to brand a number on the skin. Letters of iron are heated and the figure burnt in. The skin of the place gets burnt and a sore develops. After healing a scar is left. The advantage of this method is that the animal can be identified from a distance, and it need not be

approached close. This method involves great pain to the animal, and the hide over the part is lost for leather making. Generally, branding is done on the rump. The most valuable part of the hide is thereby injured, and its commercial value reduced.

Another method is to tattoo some letters and numbers on the under-surface of the ear. For this purpose, tattooing punches are obtainable with sets of numerals and letters. These are needle-points arranged in the holes of the punch as required. By proper setting, letters or numerals may be figured on the punch. On pricking the ear with the tattooing punch, so many little pin-points are made. A marking fluid is rubbed over, which penetrates into the pricks and thereby gives a permanant stain to the punch mark. The animal retains the marks for life. The only objection to this is that one has to approach the animal and hold its ear in order to read the number and lettering. But this objection is not serious as compared to its advantage over branding.

Sometimes branding is done on hoofs and horns. As these are growing parts, in course of time the marks may get obliterated, and therefore, needs looking after occasionally, and have to be renewed. Marking of Roman numerals on the horns or hoofs is a quite satisfactory method. A small carpenter's chisel may be used for cutting the figures in. A saw may be used for marking the numerals on the horn.

CHAPTER XXIII

FEEDING AND REARING

970. **Staple fodder of provinces :** This is the most important item in the management of animal husbandry. The nutritional requirements of the cattle have been indicated, and Tables and details have been provided, so that the required nutrition may be calculated and suitable fodder selected to answer the particular requirements of carbohydrates and proteins, minerals and vitamins. Yet, it is a task to construct a balanced diet suitable to the requirements, consisting of items which would be easily available and will form the cheapest possible combination for the requirements. No single formula can be given, and no rule of thumb can be formulated for feeding the cow and her progeny to the best advantage out of the available local materials.

Materials for feeding the cow differ according to localities, and even in the province one district differs from another. The cattle are made to live mainly on the stalks of cereals and pulses in practically all the provinces, the Punjab being an exception. In the matter of feeding materials, the available stuff will vary according to the food grains grown in those areas. Rice is an important food-grain, supporting a little over half the people of India. Rice-straw

probably supports near about two-thirds of the cattle, because rice-areas maintain much more cattle than other areas.

Wheat is another food-grain of great importance. The Punjab supports itself mainly on wheat; it is also a very important crop in the United Provinces, part of the Central Provinces, the North-west Frontier Province, Sind and Bihar. The cattle in these areas have mainly to depend on wheat-straw. Wheat-bran compensates for the deficiencies of wheat-straw, and the cattle are not in so unfortunate a plight as they are in the predominantly rice-areas. Amongst wheat-areas the Punjab stands by itself, growing as it does, an enormous quantity of fodder crop. Of the 10 million acres in India under fodder, the Punjab singly accounts for 5 million acres. The cattle of the Punjab are, therefore, in a particularly favourable position. Millets like *joar* and *bajra* are grown very largely in Madras, Bombay, the C. P., the U. P., Central India and Rajputana. The stalks of the millets are a comparatively richer fodder than wheat and rice-straws. The millet-growing areas, therefore, get a better chance of supporting their cattle.

In feeding the cows the different provinces and the districts in them will have to select different standards. The most difficult problem is that of the rice-area, both rice-straw and rice-bran being inferior, particularly as the rice-straw contains potassium in excess and calcium in the indigestible oxalate form. The problem, however, of the rice-area has been solved as already indicated by the use of correctives with

the fodder—some green grass, some legumes, oil-cake and bone-meal and plenty of salt.

And if the rice-area cattle can be fed to satisfaction, there can be no difficulty about the comparatively better-placed wheat and millet areas.

971. Feeding for maintenance : (726-'32) As a general rule for feeding cows, we know that we have to feed them with roughage to the extent of their capacity. With the roughage are to be incorporated the concentrates in the form of brans, legume-hays, cereals and pulses, oil-cakes and cotton seeds. By a combination of these we may get all that is needed for making a feed balanced.

About the roughages, it must be made a rule that at least 20 per cent or one-fifth should be green. Green fodder may be pushed up to seventy-five per cent, and with discretion to hundred per cent. But in common practice 75 per cent green would be better, requiring the addition of 25 per cent dried materials. Sun-dried roughages contain vitamin D. Stall-fed animals, not much exposed to sun-light, may suffer from vitamin D deficiency unless some sun-dried stuff are fed with the green stuff. In pastures, where the cattle graze, there is no chance of deficiency of sun-light and, therefore, of vitamin D. Where pastures are good, the animals may be kept well-nourished on green fodder alone.

For heavy milkers, concentrates would be necessary in addition to grazing in pastures, depending upon the quality of the pastures. But this is more or less an academic matter. We have little pasture, good or

bad. The matter of cows grazing on pastures alone to maintain themselves is a thing not to be found in the India of today except in some Government farms.

In Paras 731 and 737 two possible combinations with rice-straw have been given. Rice-straw is the worst straw. If other straws are substituted, according to what is available in the particular areas, the fodder would improve. For general purpose in the Tables referred to, we may read any straw for rice-straw.

Similarly for *dub* grass in Paras 737, 790 we may read green fodder, for ground-nut hay we may read legumin hay; and for linseed-cake read oil-cake in order to make their application a basic thing.

TABLE-86

Maintenance ration based on Tables Paras 731 & 737

	500 lbs. cow.		800 lbs. cow.	
	Formula A	Formula B	Formula A	Formula B
Straw	8 lbs.	7 lbs.	12½ lbs.	11·2 lbs.
Green fodder	2 lbs.	2 lbs.	3·2 lbs.	3·2 lbs.
Legumin fodder	nil.	1½ lbs.	nil.	2·4 lbs.
Oil-cake	¾ lb.	nil.	1·2 lbs.	nil.

In order to give the requisite protein, phosphorus and calcium, we chose in the Tables 51 and 53 (731, 737) *dub* grass amongst grasses and ground-nut hay amongst legume fodder and linseed-cake amongst oil-cakes. For the purpose of generalisation these specifications have been removed from the above paragraphs. Any green fodder, any leguminous fodder and any cake are substituted with the concomitant risk of deficiency.

This risk will vanish by being more liberal, and adding simultaneously both legumin fodder and oil-cake concentrates instead of as alternatives. In the altered form the formulae A and B merge into one as under :

TABLE—87

Maintenance ration.

	For 500 lbs. cow.	For 800 lbs. cow.
Straw	... 7 lbs.	11·2 lbs.
Green fodder	... 2 lbs.	3·2 lbs.
Legumin fodder	... 1½ lbs.	2·4 lbs.
Oil cake	... ¾ lb.	1·2 lbs.

—(648, 972, 983-'90, 999-1001, 1040, 1043, 1048, 1074)

972. **Maintenance ration in general :** The formula has now taken a satisfactory general turn. In round figures we may put the quantities in the following language :

Maintenace ration for a 800 lbs. cow.

- (1) Straw and green feed together a little ($\frac{1}{8}$ th) less than two per cent of the weight of the animal, say 14½ lbs. for a 800 lbs. animal. Of these, the green fodder should be at least one-fifth. If more green is put, the dry portion should be correspondingly less. The green feed is calculated on a dry basis. In other words, so much of green feed is to be given as would correspond to the dry weight indicated. In the rainy season some grasses on drying shrink to one-fourth or even one-fifth of their weight. In the dry season the shrinkage in

weight is one-third. The leafy fodders shrink more than the stemmy fodders. This should be kept in mind.

- (2) Legume fodder should be one-sixth of the dry-weight of the roughage.
- (3) Oil-cake should be half the weight of legume fodder or one-twelfth of the dry roughage. Taking items 2 and 3 jointly as concentrates, the two together make one-fourth of the dry fodder in concentrate.

Boiled down to a more simple form, the above result looks for a maintenance ration as under :

- (1) Dry fodder and green fodder equivalent in weight together a little less (about $\frac{1}{3}$ th) than 2 lbs. per hundred weight of the animal.
- (2) Concentrates, one-fourth of the dry-weight of the roughages.

Upon this basis any person can construct for his locality a balanced ration for maintenance. After having selected the items 1 and 2, in as much variety as is possible and convenient, the items may be put in a list and their digestibility and chemical composition put against them. If the proposed list shows any deficit or excess over the standard set forth in Paras 731 & 737, the items may be changed or their weights may be corrected.

973. Feeding the milch cow : (770-'71) For feeding the milch-cow additional concentrate has to be put in over the maintenance-ration, so that for every pound of milk the following supply is ensured as given in Table 57, Para 770.

TABLE-88

*Additional requirement for milk
over maintenance.*

	For 1 lb. milk.	For 10 lbs. milk.
Digestible protein	·05 lb.	·5 lb.
Starch equivalent	·30 lb.	3·0 lbs.
Calcium (CaO)	·5 gram.	5 grams.
Phosphorus (P ₂ O ₅)	·4 gram.	4 grams.

Taking, for example, a case of a 10 lbs. milker we may find out which weight of suitable concentrates will meet the needs for protein etc. It is the usual practice in some places to add pulses to the feed for milch-cows over the maintenance requirement. Following this practice we may look up the Table for a pulse. *Urid* is a suitable pulse for milch-cows. Unfortunately the list in Para.927 does not give any figures for *urid*. The only pulse tabulated is gram. Although we may, in practice, use any other suitable pulse, we may for the calculation purpose take the digestibility figures for gram.

TABLE-89

Nutrition-value of gram.

	Percentage weights.		Requirement
	Per 100 lbs.	Per 5 lbs.	for 10 lbs. milk.
Crude protein	14·33 lbs.	·7 lb.	·5 lb.
Starch equivalent	78·5 lbs.	3·9 lbs.	3·0 lbs.
Calcium (CaO)	0·16 lb.	0·008 lb.	8·6 gm. 5 grams
Phosphorus (P ₂ O ₅)	0·93 lb.	0·047 lb.	21 gm. 4 grams

We find that 5 lbs. of gram pulse has very nearly all the digestible starch equivalent necessary. Calcium is near the requirement, while phosphorus is much in excess. Another pulse will show another result, but we have got this roughly that for every 10 lbs. of milk 5 lbs. of pulse will be near the requirement. This is the practice in many well-conducted dairies. The net result is that for a milch-cow the following feed is necessary for maintenance and milk :

974. Ration for milch cow : (770-'71)

- (1) Roughage or dry and green fodder (green fodder reduced to dry equivalent) at a little less rate (about $\frac{1}{5}$ th) than 2 lbs. per 100 lbs. weight of the animal. Green fodder should not be less than one-fifth of the weight of dry fodder.
- (2) Concentrates of mixture of several items, such as legume fodder, bran, oil-cake etc., one-fourth of the weight of the roughage.
- (3) For every pound of milk half pound of pulses.
- (4) Bone-meal to the extent 2 to 3 ounces per head, specially in the case of rice-straw feeding.
- (5) Salt $\frac{3}{4}$ ounce to 2 ounces per day according to the nature of the feed, the larger quantity for rice-straw.

As a general statement it is necessary to emphasise the fact that in the generalisation made above only 20 % dry equivalent of green fodder has been provided for. The more the green fodder the better will be the feed, and the less will be the necessity of concentrates. If suitable green fodder is found then the cow may feed wholly on it. Only the concentrate

requirement for milk is to be added. In the matter of dry fodder also the basis is the poor material like rice or wheat-straw. For better material less concentrates would be necessary.

It should also be noted that the concentrates mentioned consists of legume hay two parts mixed with oil-cake one part. It is an inferior concentrate. If richer concentrates are used less will be necessary. For milking, a rich concentrate only in the shape of a pulse has been provided for.

We have now got something very tangible and suitable to be taken as a basis to be worked out for the fodders and concentrates available for the locality. Stated more categorically the formula resolves itself into the following items :

Feed for a 800 lbs. cow giving 10 lbs. milk.

- | | |
|--|-------------|
| 1. Roughage—80 parts dry and 20 parts
equivalent of green fodder | ... 14 lbs. |
| 2. Concentrate for maintenance 3·6 lbs.
Additional concentrate
for 10 lbs. milk 5 lbs. | } 8·6 lbs. |

975. Macguckin on feeding : Captain C. E. Macguckin, Controller, Military Dairy Farms, Northern Circle, published in the "Indian Journal of Veterinary Science & Animal Husbandry" of 1931, Page 124, some "Practical Feeding Tables for Dairy Cattle in India." Therein he calculated the feeding requirement of a 800 lbs. milch cow fed with 75 per cent dry and 25 per cent green fodder amongst other, as under :

Roughage dry calculated (75% dry, 25% green)	14 lbs.
Concentrate mixture	6 lbs.

The concentrate mixture is to be as follows :

Wheat bran	...	...	4 parts.
Ground <i>toria</i> cake	...	...	2 „
Gram husk	...	...	2 „
Gram	...	...	1 part

It will be observed that Macguckin's concentrate mixture is richer than the mixture contemplated in the fore-going schedule in Para 974. The roughage also is calculated to contain 25 per cent green fodder as against 20 per cent provided for by me. The more the green fodder the less is the concentrate required. In place of 8.6 lbs. concentrate tabled by me, Macguckin's Table allows only 6 lbs. The roughages are 14 lbs. in both the Tables. Considering the two points of extra green feed and inclusion of gram in the concentrate in Macguckin's Table, I think there is no material difference between the two Tables, at least there is as much of uniformity between the two as could be expected from Tables calculated from different angles. Macguckin had a definite choice of better fodder, but I have to allow for dry fodders which may be as degenerate as rice or wheat-straw only. As a general practice my Table stands with this recommendation, as has been already mentioned, that when the actual items of fodder and concentrates are filled in, their digestible nutrients should be calculated and compared with the basic Table given for maintenance in Paras 731, 736 & 770, and if necessary, the required adjustment made. This was not possible at the time (1931) when Macguckin's Tables were published.

But his Tables need more than a passing notice. The main features of his calculations and the Table for the feed of milch-cow are, therefore, given below in some detail. It will allow the reader to study the problem from the point of view of one who is a very experienced expert, qualified to guide in the matter.

976. Features of Macguckin's Table : "...Of all the processes on a dairy farm, perhaps, the art of feeding cattle is the most difficult to standardize. "The factors involved are numerous, many vary from day to day, and although an immense amount of scientific help, in the shape of data based on accurate research work, is available, much of this data may be most misleading when applied to local conditions.

"In putting forward these Tables, I therefore, do so with diffidence and only claim that they fulfil three conditions, which *inter alia* are, in my opinion, essential in any system offered to the ordinary farmer, namely :

- (1) They take into consideration the main factors involved in feeding cattle.
- (2) They are simple, as they require the minimum amount of calculation at infrequent intervals.
- (3) They can be easily modified to suit local conditions and the increasing experience of the feeder.

"...I shall, therefore, merely, briefly discuss the main factors a farmer has to consider when computing rations for his animals and how these factors have been allowed for in these Tables."

977. Macguckin's classification of foods : "For the ordinary farmer to obtain accurate analyses of the various foods he is feeding is not practicable. This applies specially to fodders, which form the bulk of his rations. Fodder, even of the same varieties, differ greatly in feeding-value depending on such factors as the soil and climate in which grown, time of cutting etc.

"In these Tables fodders have been divided into four categories ; these have been found sufficient in Northern India, without making the Tables too complicated. The quantity of concentrate mixture is fixed to bring the feeding-value of the entire ration up to what is at present considered the most economical standard for the various animals. These figures are based on feeding for the past 6 years, over 3,000 animals scattered over the Punjab, North-West Frontier Province and Baluchistan."

In the Ration Table Macguckin classified the roughage into classes A. B. C. D.

Class A. In this the roughage is wholly dry, such as *bhoosa*, *kirbi* and dry grass etc. (*Bhoosa* is the leafy and flowering parts and husks of pods etc. in a broken condition ; *kirbi* is the stalk of millets, maize etc.).

Class B. In this, approximately 75 per cent of the fodder is dry and 25 per cent green or 100 per cent early-cut and well-cured hay.

Class C. In this 50 per cent is dry and 50 per cent is green fodder.

Class D. In this 25 per cent of fodder is dry and 75 per cent green.

"Important. It is never advisable to feed 100 per cent green fodder to cattle, specially if the fodder contains excessive moisture.

"Note 1. Roots and silage count as green fodder.

"Note 2. When green fodder with an excessive moisture-contents is fed, e.g. Berseem, roots etc., $33\frac{1}{3}$ per cent extra to what is allowed under the green fodder category should be given."

"Note 5. If fodder is not chaffed or cut up, 20 per cent extra should be fed."

978. Macguckin's Ration Table: The first four columns give pounds of concentrates for milking herd weighing up to 800 lbs.

TABLE-90

Daily milk yield. lbs.	Concentrate mixture in pounds.					Fodder quan- tity to be fed.	
	Fodder class A. All dry.	Fodder class B. 75% dry 25% green.	Fodder class C. 50% dry 50% green.	Fodder class D. 25% dry 75% green.	Fodder		
						dry. lbs.	green. lbs.
1—3	5	3	2	...		14	70
3—6	6	4	2	1		"	"
6—9	7	5	3	1		"	"
9—12	8	6	4	2		"	"
12—15	9	7	5	3		"	"
15—18	10	8	6	4		"	"
18—21	11	9	7	5		"	"
21—24	12	10	8	6		"	"
24—27	13	11	9	7		"	"
27—30	14	12	10	8		"	"
30—33	15	13	11	9		"	"
33—36	16	14	12	10		"	"

The Table shows that when Class B fodder is fed or 75% dry and 25% green is fed, the concentrate for a 9-12 lbs. milker should be 6 lbs. It will be seen that this Table allows one pound increase of concentrate for every 3 lbs. increase in milk. I have allowed for 1 lb. of concentrate for every 2 lbs. increase of milk. In case of the better-fed cows on better-grade fodder and better-grade concentrates, the last may be given at the rate of one pound for every 3 lbs. of milk. But for poor, dry and poor green stuff it is wise, where conditions like those under observation of Macguckin as at the Punjab and N. W. F. P. stations do not exist, to give 1 lb. of concentrate to every 2 lbs. of milk.

Macguckin's concentrates for the above Tables is a mixtures of

Wheat-Bran	...	4 parts.
Ground <i>toria</i> -cake	2	„
Gram husk	...	2 „
Gram	...	1 „

He has, however, provided for the use of other concentrates and given each concentrate a certain arbitrary but comparative value so that in case of change from one concentrate to another the proper quantity of a new mixture may be used.

979. Macguckin's concentrate values :

TABLE-91

Concentrates.	Unit value.	Category No.	Minimum & maximum percentage of each category which should be in final mixture.	
			Minimum. %	Maximum. %
Linseed cake ...	74	I	30	60
Til cake ...	72			
Toria cake ...	65			
Cotton seed ...	63			
Mustared cake ...	61			
Gram ...	68	II	25	50
Oats ...	60			
Maize ...	81			
Wheat bran ...	43	III	...	40
Gram husk ...	35			
Cotton seed husk...	10			
Rice husk ...	8	IV	...	25
Barley ...	71			
Wheat ...	72			

Macguckin has worked out an example to show how this valuation of concentrate is to be actually worked out.

His original concentrate-mixture consisted of the following, and their values were given as follows :

4 lbs. Wheat-bran	... $4 \times 43 = 172$ units.
2 lbs. Toria cake	... $2 \times 65 = 130$ „
2 lbs. Gram husk	... $2 \times 35 = 70$ „
1 lb. Gram	... $1 \times 68 = 68$ „
9 lbs.	... Total—440 units.

Therefore, for every pound of the mixture there are $440 \div 9 = 48.9$ units (approximately).

If the above mixture of concentrate is used, when say, 6 lbs. of concentrate are given to Class B feed of a 800 lbs. weight and a 9-12 lbs. milker, then these 6 lbs. will carry 6×48.9 or say, $6 \times 50 = 300$ Macguckin units.

We may give those 300 Macguckin units by any other mixture within the limit shown at the right end of the concentrate valuation Table. We may not use any single item to get these 300 units, but should restrict the items to certain proportions indicated in the Table.

Suppose a concentrate-mixture is made of

3 lbs. Linseed cake	...	$3 \times 74 = 222$	units.
1 lb. Barley	...	$1 \times 71 = 71$	„
2 lbs. Wheat bran	...	$2 \times 43 = 86$	„
3 lbs. Gram husk	...	$3 \times 35 = 105$	„
<hr/>			
9 lbs.	...	Total— 484 units.	

Each pound of concentrate here has $484 \div 9 = 53.8$ units. The standard mixture was of 48.9 units. This last mixture is approximately $\frac{1}{10}$ units stronger than in 48.9 units or 10% stronger. Therefore, if the new mixture is issued, 10% less concentrate than the tabled weight should be used.

980. Green fodder : Macguckin and Sen : It will be noticed that Macguckin has put green fodder 70 lbs. as equivalent to 14 lbs. of dry fodder. The calculation of Dr. Sen in his Table of dry equivalent of green fodders in Para 927 has been based as under :

(a)	All dry materials, such as dry roughage, cake, grain etc. ...	90 per cent.
(b)	Succulent silage ...	30 „
(c)	Green pasture, green maize ...	25 „
(d)	<i>Joar</i> prime ...	30 „
(e)	„ ripe ...	40 „
(f)	Green legumes like Berseem and Lucerne ...	20 „

Green fodder 70 in place of 14 dry is allowing 5 times green to represent dry fodder. The basis comes to 20 per cent dry matter. Extra allowance of another $33\frac{1}{3}$ per cent is made by Macguckin for specially moist feed such as Berseem and roots. These figures appear to be excessive.

The basis of Dr. Sen appears to be sounder, and should be followed in the conversion of green feed to dry basis.

981. Stall-feeding combined with grazing : In actual practice, in the village, some amount of feeding will be provided by grazing. Then the amount of provision of total feed becomes a matter of guess work. It is, however, not absolutely guess work. There is a way to find how much feed the cow has taken by grazing by finding how much extra feed she would take in the stall. The provision of 2 per cent of dry matter per 100 lbs. of body-weight is based on the fact that cows allowed to take their full generally take that much and are well maintained on it. In practice, cows should be allowed to take as much roughage as they can conveniently take. If, therefore, after grazing, a cow is stall-fed, the measure of stall-feeding gives by

difference what she has taken in during grazing. The amount of green feed she has taken in by grazing then will regulate her need of concentrates. The nature of pasture will also determine the amount of concentrates needed. If she is allowed to graze on a legume pasture like that of Berseem or Lucerne she will not require any concentrate at all, if she has fed herself full. (587, 596)

982. Curtailments for grazing: Macguckin gives the following as a guide for the *Curtailment in concentrates for grazing* :

*Curtailment of concentrates in stall-feeding
for grazing cows.*

When grazing is fair	...	25 per cent.
„ „ is good	...	50 per cent.
„ „ excellent	...	75-100 per cent.

“Animals on permanent closely-grazed yet abundant and green nutritious pastures should be fed on concentrate mixture class D. less 50 per cent.” (Macguckin Table) Macguckin adds the note that “it is difficult to over-estimate the advantage of natural permanent nutritious pasture for economic milk production.” (596)

983. General principles in feeding: We start with an idea of what to feed to a cow in order to provide her a square ration. To recapitulate, we give her all the roughage that she can take, and allow some extra concentrate to about $\frac{1}{4}$ th of dry feed according to the feed she has taken ; more concentrate being given

if she is fed on dry fodder. The more the share of green fodder the less the necessity of concentrates, and if legumes form a part of green feed they themselves supply the requisite of concentrates. For milch-cows we allow 1 lb. of concentrate for every 2 lbs. of milk. This ratio is to be less the greater the quantity and better the quality of green feed. For making up mineral deficiency, bone-meal has to be given and some salt from $\frac{3}{4}$ th ounce to 2 ounces per day should be given ; the necessity for salt being greater in case of stall feeding. (971)

984. Feeding for milk : After calving the cows have an urge for discharging milk. This natural urge is taken advantage of for getting more milk than nature designed her to produce for her calf. She has admirably answered to the demand made by man over her natural function. By proper feeding she delivers the extra feed back to man in the form of increased milk. It has been estimated that after the maintenance ration is fully supplied, whatever extra is given to a cow, she converts half of that into milk. Here she behaves like a machine. Feed her and get milk. But all machines are not equal in their efficiency, and so, all cows do not convert fodder into milk equally efficiently. In some, the capacity for making milk is constitutionally limited. When more is fed to such a cow the extra feed goes to make flesh and fat for her for the simple reason that she is not endowed with the constitution to make more milk than a certain amount. Extra feeds are then wasted. When by increasing the feed and the

concentrates the milking does not improve, the cow pleads that her machinery for milk production is failing her, although she might digest all that is given her. In such a case, the owner should take note and restrict her diet to her milking capacity.

On the other hand, even if given inadequate feed a cow on calving will give her yield of milk. But if the feeding continues to lag behind, in spite of the cow's desire to discharge milk, the milk-source will dry up and the yield will fall till a balance is reached between her feed and her milk-yield. In order to draw out the best in the cow it is wise to let her have liberal feed, till she comes to a steady position, when further increase in feeding gives no more economic return. (971)

985. Under-feeding is uneconomical : Under-feeding a cow never pays. That under-feeding a milch-cow is uneconomical, every farmer understands, because by putting in a little more feed its equivalent of milk is obtained. It is difficult, however, to create in the farmer the same keen sense of economy about feeding a dry cow. Under feeding a dry cow means ruining the herd. An under-fed cow will, if in calf, give to a proportionate extent, a badly constituted calf and herself will not be able to milk as she would otherwise have done. Neither will she remain in milk for a long time. The total lactation yield will be very appreciably less.

In the matter of feeding the milch-cows, it should not be forgotten that the excess of the feed given over maintenance ration, goes to make milk. Suppose a

cow requires 10 units for maintenance and 10 units for milk production, a total of 20 units. She is given only a feed of 15 units. Under the circumstances, milk flow will diminish not at the ratio of 15 is to 20, but it will be halved. For, of the 15 units under reduced supply, 10 will go to maintain her. She will have a reserve of 5 units only for lactation in place of the 10 units required. She will regulate her lactation to the 5 units only or give only half the milk. If she is fed 10 units only, she will cease to produce milk, and utilize the 10 units for her maintenance only, and maintain herself fully.

Under-feeding is there on account of the scarcity of fodder. This can be remedied by ways indicated in Part II. by increased yield of crops, by proper compost manuring and thereby releasing a certain cropped area for fodder. The tree fodders may also be helpful. The growing of leguminous crops after harvesting, for example, can create at once an increased supply of very valuable fodder and give added fertility to the soil on account of the nitrogen fixed at the roots of legumes by bacteria. (971)

986. Feed cows individually : Individual care should be taken in feeding the cows. The herd is to be divided into separate groups according to age, and the milch-cows are also to be dealt with separately. All milch-cows will neither require nor deserve the same feed. The greater the quantity of milk the more of feed and concentrates will be necessary. Therefore, cows should be fed individually according to their needs. A basic common ration

may be distributed to all cows, and then the extra concentrates should be given according to the yield of milk of the cows. This presupposes the need of keeping records. Milk is to be entered in the names of the cows, every day, in a Register, and the extra concentrates should be accordingly regulated for feeding for each. As a cow lessens milk with the advance of lactation, her portion of concentrate is to go on being reduced, while on calving she will require her portion of concentrate to enable her to yield milk to the full. (971)

987. Palatability of feed : It is not enough that a feed should be square, but it should be palatable to the cow as well. Palatability is not often measured by usefulness. It depends greatly upon the temperament and habit of the cow. When a cow is habituated to one sort of food, she is likely to refuse other stuffs. The cow is a very conservative and persevering animal. If you go on giving her both coarse and inadequate food she will adjust herself to the coarseness, and to a large extent she adjusts herself to the inadequacy also by extracting more nutritives than she otherwise could have done. It is generally said that Indian cows can extract more nutrition out of a feed than the imported cows of European origin can. The Indian cow has adapted her constitution to the poverty of her keepers. The extent of accommodation in feeding may appear to be amazing. The ration on which our cows live are said, in general terms, to be 45% deficient. Still the cows manage to live, emaciated, tick-infested,

bony, and an easy prey to epidemic diseases though they may be.

It is this conservatism and her struggle to do the utmost out of a feed that has only made her live on, in spite of the staggering neglect to which she has been thrown for the past two centuries. It is this conservatism again that makes her fastidious about any new food presented to her. If any change in feeding is desired, it should be introduced gradually. If, for increasing the milk-yield, some change in food is desired and the change is made all on a sudden, she will probably refuse to take the usual quantity of her feed, and there is likely to be a fall in the milk-yield.

Palatability comes gradually by habit, and even a feed not liked at first is liked afterwards and indeed may be relished. The concentrates are naturally palatable to the cows and so also is salt. If a cow is given concentrate separately with salt and cake, and then given her full feed of roughage, she will be unable to take what she would have taken if the concentrates and the roughages were mixed together, specially when the roughages are like dry straws of rice or wheat. Palatability may be induced most commonly by addition of salt ; but condiments are still better. Condiments find a place in cow feeding for increasing palatability when occasions arise.

Evil-smelling, musty, mouldy food should not be given. Moulds are dangerous. Cases are known where animals have died on eating mouldy grain, unfit for human consumption, being given to them.

Usually such food is rejected by the cow. But hunger may get the better of their sense or the unpalatability of such food may be hidden intentionally by mixture with salt etc. (971)

988. Variety of foods : The greater the number of items of which the feed is composed the better is it for safety. Science has not yet gone to the root of the requirements and of their presence in suitable form in the available foods. It is wise, therefore, to select several items not of the same nature for the composition of the feed. Thereby there is a chance of what may be lacking in one coming from something else. Grazings and main roughages should be as varied as possible. When a varied mixture is made, there is no necessity of changing them, and the chosen composition may continue till the seasonal harvest changes. A good assortment carried from year's end to year's end will not be harmful, and the conservatism in the matter of taste of the cow will not make stereotyped foods unpalatable.

When the cows show abnormal hunger, the cause has to be sought for and remedied. Abnormal hunger is shown by attempts to pick bones, eat earth, leather etc. This indicates deficiency of mineral ingestion. The remedy should be sought for in the direction of supplying minerals in the form of calcium phosphate from bone-meal or in the form of calcium from powdered shell. Salt-hunger can be easily detected and satisfied. It has been mentioned in the Chapter on Nutrition that blocks of rock salt should be kept accessible to cows for licking. (971)

989. Preparation of the feed : Boiling concentrates are unnecessary. Passing through grind-stones is the only treatment necessary, and they may be best given dry. This way, it is easy to distribute individual rations of concentrates. It is said that by boiling, the proteins of pulses or cereals may become less digestible. The dung should be examined every now and then to see if any unaltered particles of cereals or pulses are being thrown out, and the feed should be regulated accordingly, and boiled pulses given for better digestion. Soaking of concentrates is a good measure specially for hard grains. For whole grains or *Kalais*, sprouting is an excellent way of presenting a feed. By sprouting vitamin A is developed and the grain also becomes easily digestible. For sprouting the same method is to be adopted as described for malting in Para 1166. In some dairies it has been observed that feeding of sprouted cotton seeds not only helped to increase the yield of milk but brought the cows to heat quicker. This may be due to the presence of vitamin E in the germinated seeds.

Straw should be chaffed or cut to about 2 inches lengths, and hard stalks to yet smaller bits. If entire straws or stalks are given there is a great deal of waste and the ingestion is less than it would otherwise have been. It will pay to spend the labour of cutting the roughage to size.

Straws and stalks should be soaked to softness in the feeding trough. The feed is to be placed in the feeding troughs, moistened with the requisite quantity of water and mixed with salt and cakes and

concentrates. Some veterinarians are of opinion that the better practice is to feed the stalks dry which helps better internal secretion for digestion. Feeds should be placed when the byre is empty of cows.

Concentrates, when given by themselves, without admixture with roughages get a better chance of digestion. Cows may be fed the concentrates separately. In this case, roughages become the less palatable, being deprived of concentrates. This fact should also be considered and the feed so managed that the total quantity of roughage is eaten with or without admixture of concentrates. When the cows come to feed they will find soft and palatable food ready.

When cereals are given, care should be taken to guard these before, during and after distribution. Cows or calves may steal and eat any quantity with disastrous results. The ingestion of large quantities of fermentable food-grains gives rise to the production of gases, which by failure to be thrown out at the rate at which they are formed create bloating. Bloating may cause pressure to be put on the diaphragm and interfere with respiration ; the diaphragm may even burst leading to fatal consequences. Cases of bloating may occur in the farm unless precaution is taken that the animals do not, at any time, have access to the supply of cereals.

Cooked rice or *dal*, the excess in houses after feasts, if given in large quantities, bring about bloating and death. Care should be taken to avoid such accidents. (971)

990. Number of feeds : The cattle may be fed twice daily, morning and evening, with a small quantity given at the mid-day interval. For the milch-cows the day may begin with milking in the early hours. There should be a clean-up of the byre followed by distribution of feed, while the cattle are away, taking exercise, grazing or getting cleaned. On return they find the meal ready. They eat pretty fast, one hour or an hour and a half being enough for ingesting half the day's ration. They rest after eating, and after a certain interval begin quietly to ruminate, and love to remain undisturbed.

During the noon, after another milking, where there is the practice of three milkings a day, the cows are given a smaller quantity of feed, after which they are milked in the evening. It is then that the remainder of their ration is given them for the night. They ingest and ruminate this and get ready for the early morning milking.

The time for working bullocks should be adjusted to the needs of the field. When they go to work very early, they may be given feed still earlier. One may be given after they return from work, and the third meal may be given in the night. But those animals that have other times for work, feeding and working hours should be so interspersed that the cattle may get plenty of time to lie quietly and ruminate.

991. Laxativeness of feeds : The laxative character is imparted by the ingestion of green feed. From this point of view also green feed is indispensable. On the other hand, too much of very

succulent and watery fodder may cause the dung to be thinned down to the condition of the stool of diarrhoea. Both these aspects should be kept in view. Again, on giving proportionately larger quantities of dry feed disorder of indigestion is likely to follow.

992. Bulk of feed: The feed should be bulky. The stomach and intestines of the ruminants are constructed for bulky foods. There is a great deal of difference in the constitution of the ox and of the horse. The horse has two pairs of teeth by which it may reduce its feeds to bits, and then there are powerful grinding teeth to masticate and grind the feed. The stomach of the horse has a lesser capacity than that of the cow, and, therefore, the horse requires more concentrated food than the cow. The ration of a cow with its usual bulky, leafy and stalky food will not be congenial to or digestible by the horse. The horse will not be able to ingest so much material. Its stomach wants food of more concentrated nature and of less bulk. The horse helps the digestive process by chewing while eating. The cow swallows its food rapidly and then ruminates leisurely. The cow-keeper, therefore, should take care to provide bulky food. If food of the same food-value be given to a cow in concentrated form, she will quickly finish the concentrated foods and ask for more to fill her belly. If she is refused, she will fret and attempt to eat whatever material comes in her way—ropes, leather straps, box covers, canvas paper or cloth or anything like refuse earth, dirty rags, bones etc. to satisfy her hunger for filling the bulk. Without a bulk the fullness or

satisfaction of allayed hunger does not come, and this creates the craving for food to which the animal responds.

993. Drinking water : There should be a plentiful supply of clean water near their feeding troughs so that whenever the cows feel thirsty they may have sufficient water to drink. They adjust their thirst to the quantity of moisture in the feed, so that if very watery fodder is given they drink less water, while with dry fodder they require much more water to drink.

994. Keeping records : In order that the cows may be fed individually, according to their requirements, it is necessary to keep records dividing the herd into various feeding grades and allowing definite rations for the groups. The milk-yield of every milch-cow should be recorded after milking every time. The feeding of concentrates to them can be regulated only by these records. The matter of keeping all other records is dealt with separately.

995. Covering a cow : At a certain time after calving the cow comes to heat and needs the service of a bull. In scientific language it is called "œstrum". In this period the cow desires the company of the male. It is a physiological factor and devoid of volition. It comes when the ova is matured in the ovary. There is a peculiar systematic excitement in the animal which lasts for some time and then passes off. The cow becomes feverish and irritable, her appetite becomes irregular, and the milk-flow diminishes. A watchful

cow-keeper can understand when a cow is coming to heat even before she becomes unmanageably restless. The genital organs become swollen and congested with blood and mucus is discharged from it. The cow frequently bellows and gallops about with her tail raised. She jumps over other cows, which is a sure sign. Oestrus in the cow lasts from 4 to 12 hours. The bull has to be shown within this period. The earlier the cow is brought to the bull, during the heat, the better. After a time, even if the cow be nervous, if the heat is passed, the bull would not cover her. At the proper time the cow should be presented to the choice bull.

There are two opinions about keeping the bull with the herd. Some are in favour of it, others condemn this practice. I consider it advisable to allow the bull to remain with the herd while grazing or in ranches. The bull is a better detector of heat in the cow than any human attendant. There is little chance of missing the covering, once the cow is in heat. The bull and the cow should be separated after one successful getting up of the bull. If kept together longer, the bull will waste its substance and become less fit for the next service, if it is soon needed, and the cow also will get exhausted. If once they have met, the purpose has been served. Repeated actions do not necessarily make the covering more successful.

A cow can be allowed to be covered when she is in the third month of her calving. If she gets heated earlier she should be prevented from meeting the bull,

because too frequent calving may exhaust her. If covering takes place in the third month, she will calve after 9 months or after a year of her previous calving. Calving earlier than at one year's interval is not desirable. If she will not come to heat in four or five months, the matter should cause anxiety to the keeper, as delayed calving means loss in milk, although not always so. There are cows which get heated after 7 months and give a calf on the 16th or 17th month, and in the meantime continue their lactation for over 12 months.

996. Delay in coming to heat : When a cow is delaying to come to heat the cause has to be explored. She may be getting fatty, and excess of fat causes delayed oestrus. She may be losing condition which necessarily causes delayed oestrus. If the cow is not properly cared for while in milk or when dry, her want of nourishment may be the factor. Therefore, the health of the cow should be watched in case of delayed oestrus, and if there is any fault towards over-feeding or under-feeding, such faults should be corrected.

997. Hormone injection for heating : When the cow fails to come to heat it means that the necessary hormones are not being generated. The root meaning of the word *hormone* is stirring up. Hormones are substances which, on absorption in the blood stream, influence the tissues or organs other than those in which they have been produced. The internal secretions of the glands of the ovary, testes, thyroid etc. are examples of hormones.

The urine of pregnant cows contains this body. When the hormone is separated from the urine and injected subcutaneously, it causes the ovaries to be excited to action and may successfully bring in œstrum. Injection of urine was hitherto used for the diagnosis of pregnancy. But, in this instance, it is used to create a reaction in the animal to induce pregnancy.

The technique recommended by the Institute of Animal Genetics, Edinburgh, was tested by P. T. Kerr I. V. S. in India. He has found a simpler method than that recommended by the above Institute. The older method depended upon the separation of protein-substances from the pregnant cow's urine by precipitation with sulpho salicylic acid. Kerr, however, found that better results are obtained by the simpler method of subcutaneous injection of pregnant cow's urine collected and injected in a sterile condition. He wrote :

"..... we have found it practicable and safe to simplify this method for general use, provided the pregnant urine for injection can be obtained fresh and used at once ; the practice is to collect it in a sterile mug discarding the first few ounces voided. It is then filtered through ordinary filter-paper and injected subcutaneously in doses of 10 c. c. per 100 lbs. body-weight with ordinary aseptic precautions. One dose is given daily on four consecutive days. This treatment is already in use in a commercial dairy and has proved valuable. It has also been used by my staff in the treatment

of bulls kept by public bodies and jail cows, and in the majority of cases it has proved satisfactory."

—(*2nd meeting A. H. Wing, 1936.*—P. 141).

The technique is quite simple and can be carried out by those accustomed to giving injections to men or cattle.

As an immediate effect of injection, cows diminish their milk-flow which then gradually rises, but not always to the former level. This has been my experience.

In three cases injected by me all responded, one in 11 days, the second in 21 days and the third after a month after injection.

It should be a valuable instrument in the hands of those who want to see their cows regularly coming to heat.

TEASING TO BRING A COW TO HEAT : A method of preventing delayed heating is to keep in the herd a scrub bull with a piece of gunny hanging in front of its sheath and tied to its belly over its back. Such a bull will tease the cow to come to heat. He cannot cover, because of the protecting piece of gunny. When the cow comes to heat on teasing, the sire of the herd covers her.

998. Artificial insemination : Instead of bringing a cow to a bull, she can be artificially inseminated by injection of properly collected and preserved semen. The advantage of this method is very great. For the semen of a proven bull may be used for inseminating cows at distant stations, and thereby improving the breed rapidly. The process is not

practised in India, and there are difficulties here which may not make its extended use possible. But in other countries, Russia for example, the practice is very general, and extremely satisfactory results have been obtained. Failures after injection have not been more than with natural insemination. Successful natural insemination occurs to the extent of sixty to seventy per cent of coverings.

In the artificial process the chosen bull is made to cover a cow having a rubber capsule inserted in her vagina. The ejaculate is collected in the rubber tube and preserved in a laboratory under paraffin oil. Another method is to hand-manipulate the bull in such a way that the ejaculate comes out and is received in a collecting vessel. The sperm can be kept alive for 20 days in a gluco-phosphate dilution fluid at a temperature of 15° to 25° centigrade. The semen can be transported in specially constructed receptacles without diminishing its potency. A single ejaculate may inseminate a very large number of cows. The Imperial Council of Agricultural Research in India has in hand a scheme for the introduction of artificial insemination. The 1941-'42 Report mentions that the scheme could not be started during the year as the officer in-charge of the scheme had not till then been recruited. Some experimental work is, all the same, going on in India.

999. Feeding and care of dry and pregnant cows :
In a normal herd a cow is pregnant before she is dry. Therefore, the question of the care of dry cows is also the same as that of pregnant cows. Where the cows

are dry and yet not pregnant, the cause should be investigated and methods adopted to bring her to heat by the improvement of her health or by the injection of hormones. If there is some organic trouble, these methods may not succeed. The cow should, if possible, be examined by an experienced animal husbandry technician. The veterinary assistants in the employ of the Government and District Boards are not generally trained for this work and may not be of substantial help. It is only now that animal husbandry and dairying are being given attention to in our Veterinary Colleges. The result of the effort may become noticeable after some years.

When a cow is pregnant from the milking stage, then it can be assumed that she has been receiving ample rations to maintain herself and to continue to give milk. If she has not lost condition then nothing need be done specially to her, except giving her all the exercise she needs in a pasture. Allowing her to graze, and supplementing the feed by stall-feeding, will be all that is necessary for the first months of pregnancy. (971)

1000. Regulation of feeding in pregnancy : The feeding of the cow while dry will depend largely upon her condition. If she is in a fine condition and somewhat more than moderate in flesh, a little more than the mere maintenance ration will be necessary. She, however, should not be kept in a high condition. Legume pastures are very good for her. The same feed that she was having while in milk, less the extra addition for milking, will be all that is

necessary. As has been mentioned already, the feed should be regulated to milk production. When milk-production ceases the quota of feed for milk is to cease, and, therefore, when she gets dry she is already on a feed of maintenance. Even in pregnancy, this feed is to continue unless she has lost flesh. No special food is necessary for a dry pregnant cow till she is within 2 months of parturition. Prior to that she must be kept in good condition. If she is not, the same mixture approved for milch-cows will have to be given, the quantity of concentrates depending upon her condition and the amount of improvement desired. During the last two months special and careful feed should be given to keep her in condition.

If she is not in good condition, her milk-flow will be less after the next parturition, and difficulties, such as retention of placenta, may occur at the time of calving. People may think that the need for feeding during pregnancy is for the foetus she is carrying. This is erroneous. The tax upon a cow for the foetus is very small. A calf weighing 40 lbs. at birth has only about 10 lbs. of dry matter. A cow in producing 80 lbs. of milk produces as much dry matter. The case of the pregnant human mother is quite different from that of the milch cow. Because the former has to spend comparatively much more material to build the human child. (971) •

1001. Feeding the dam & size of the calf : There is another belief that if a cow is not well-fed during pregnancy the calf will be under-sized. If there is vitamin deficiency the calf may not live at all, but as

regards size and weight the calf is not likely to suffer because of the mother's leanness. The calf takes its necessary quota from the mother's flesh and blood and bone, whether the mother is up to it or not. Of course, in very abnormal conditions the calf will be affected, but not under the ordinary case of neglect of the cow. The neglect will, however, affect both the mother and the owner, for she is bound to give less milk in freshenings if she was not maintained in the pick of condition during the period of gestation. The lactation following will be disappointing, and although she may be given the very best and nutritious of feeds after calving, it would be too late to have any effect for that lactation. (971)

1002. Pusa experiment on milch cows : Imperial Agriculturist Wynne Sayer has worked out a process for handling cows. A detailed consideration of his method will help to throw a great deal of light on the management of the dairy cow. His papers were published in the "Agriculture & Live-stock in India" March and September, 1934.

In our feeding Table, 1 lb. concentrate allowance for every 2 lbs. of milk has been provided for, and it has been indicated from Macguckin's observations on the feeding of milch-cows that if the cows are fed on rich roughage and pasturage the necessity for providing concentrates diminishes.

At Pusa, the herd was developing undesirable qualities, and Wynne Sayer attributed these partly to over-feeding of concentrate and partly to the existing methods of handling at Pusa and elsewhere. He

thought out remedies and applied them with complete success. His experiments are of a pioneering character and of far-reaching importance in the management of dairy cattle.

The Pusa Sahiwal herd was purchased in 1904 with 14 cows and 1 bull from the Punjab. 18 cows and 1 bull were purchased in 1910, and 2 bulls in 1923. The herd enjoyed seclusion and had no case of contagious abortion. The purchased herd began with about 5 lbs. of milk per cow per day in 1914 which rose to a maximum of 16·2 lbs. in 1928, and fell to 13·9 lb. in March, 1932. There was an all-round steady increase of milk up to 1928 ; after that the fall began and continued up to March, 1932. At this stage Sayer introduced his new technique of handling for the improvement of the herd. It had considerable green feed throughout the year, including legumin pasture. The need for concentrates was small. Still, as a routine practice, 1 lb. of concentrate was fed for every 2 lbs. of milk.

The feed for a 900 lbs. cow on analysis showed the following results :

- | | | |
|------------------------------------|---------|----------------------|
| 1. Dry fodder (<i>bhoosa</i>)... | 8 lbs. | } Fed in the
byre |
| 2. Green fodder (Berseem) | 40 lbs. | |
| 3. Grazing Berseem ... | 20 lbs. | |

(near estimate of what a cow can eat)

The starch equivalent in the above feed came to 5·54 lbs. The usual maintenance allowance of ·6 lbs. per 100 lbs. (649), required about 5·4 lbs. S. E. for a 900 lbs. cow. The feed, therefore, contained the

required S. E. It was, however, much richer in proteins as compared with the needs, because of the high-class legume and other green fodders.

The concentrate fed for milk was a mixture :

	S.E.	Crude protein.
3 lbs. oats at 60 per cent—	1·8 lbs.	9·5 per cent.
2 lbs. gram at 68 „	1·36 lbs.	28·0 „
1 lb. rape cake 60 „	0·60 lb.	37·0 „
<hr/> 6 lbs.	<hr/> 3·76 lbs.	

Total S. E. in 6 lbs. is 3·76 lbs.

Or one pound concentrates provided ·626 lb. S. E.

Half a pound of concentrate provided ·313 S. E. for one lb. of milk, while the allowable S. E. per lb. of milk was 0·27, according to Sayer, and 0·3 according to our Table 57. (770) This led Sayer to think that too much concentrate was being fed. It was really so when digestible protein was taken into account. Although at the time (1932) the protein digestibilities for Indian fodder were not known, the credit goes to Sayer for having put his finger on the right spot. He thought that too much of concentrate was being given, and decided to allow 1 lb. of the same mixture of concentrates for every three pounds of milk. The results were remarkable. Almost a magical change came over the herd not only in the milk-yield but in the matter of fertility and udder troubles also.

1003. Excessive feeding of Pusa Sahiwals : The shortcomings of the Pusa Dairy Sahiwal herd at the time of the change-over to new methods were the following :

- (1) Milk-yield was not progressing ; on the contrary, there was a tendency towards a falling-off ;
- (2) Service period was at longer intervals after calving ;
- (3) Some cows were going sterile and some heifers were proving to be inferior milkers to their dams and had to be discarded in increasing numbers ;
- (4) There were udder troubles, developing mastitis.

The reasoning that led Sayer to spot out the defects (1) and (2) were that the cows were receiving too much concentrates. They were being brought up like those that are reared for meat, because of following the British Dairy practice on this Pusa Sahiwal herd. About (3) and (4) sterility and udder troubles etc., he had other reasonings and remedies to apply. About (1) and (2) he decided to reduce the allowance of concentrates by giving 1 lb. for every 3 lbs. of milk instead of 1 lb. for every 2 lbs. of milk of the same concentrate mixture.

1004. Feed-reduction increased milk-yield : The herd veered round and in the first year, on account of this reduction in concentrates, the milk-yield went up by 47 per cent. This was slightly lowered during the second year on account of certain other temporary disturbances which had nothing to do with feeding. Yet, the increase remained at 41 per cent.

In addition to the decrease of concentrate feed for increasing the milk-yield, Sayer began milking

4 times a day at equal intervals all the cows giving over 20 lbs. of milk. The difference in the milk-yields before and after the change is shown below.

TABLE—92

Average milk-yield of Sahiwal herd under special treatment.

	No. of cows.	Average daily milk-yield.
Before special treatment ...	49	665·6 lbs.
From April, 1932 under special handling ...	49	983·6 lbs.

1005. Diminution of service period and sterility :

The service period under improved handling was reduced from 172 days to 94 days during the period of test.

“.....This shows clearly that the reduction from prime to milking condition has had a marked effect on the problems of sterility and standing off in the herd, and that the reduction in condition has been correlated with an almost total absence of sterility. This is in accordance with the general consensus of opinion to the effect that sterility is frequently linked with high condition in females.”

1006. Increasing milk-yield, frequent milking :

For increasing the milk-yield by milking four times a day, and for converting bad milkers into better milkers and for removing udder troubles, Sayer had theories and special methods of his own. He was a firm believer in the theory that the indigenous cow with her lower yield is not entirely suited to the English

methods of dairy treatment and rationing usually placed on her. He argued :

"...She is a smaller cow averaging 850 lbs. against 1,500 lbs. in an English breed and appears far more suited to smaller and more frequent milking, resembling the condition that would exist if her calf was left on her, and by her failure to respond to English methods frequently becomes classed as a poor milker without proper evidence. All cows were, therefore, brought under a reduced concentrate ration, and a 3 to 1 concentrate ratio for yield applied, based on the same ingredients and proportions, while those cows giving over 20 lbs. were milked four times in 24 hours at equal intervals and all cows and heifers for the first 30 days in milk were milked four times per day irrespective of yield."

1007. Special handling of Pusa Sahiwals : He pursued this thought further by trying to bring forth greater milk out of bad milkers. He observed that many young cows were failing to milk up to their pedigree and breeding. For this reason in former years a number of cows had to be sold off in their third season as poor milkers and not up to the standard. This was beginning to affect the milch progress of the herd seriously as became clear from the fact that the peak production of 16½ lbs. per cow per day obtained in 1928 could not be maintained.

He argued as previously on the difference in the character of the cows and thought not only of milking 4 times a day for heavy milkers but of milking the

low milkers any number of times in course of the day in order to let them develop their milching capacity.

"Now, the fact that a cow does not give milk does not always prove that she is a bad milker. It has been truly said 'in a good milch pedigree-herd, half the results are due to pedigree and the other half to management.'"

1008. **Working on heifers for milking :** "...Until a cow has definitely shown, under proper milking technique, that she has not got milk in her, she should not be condemned as a bad milker, and here it appeared to be a case of altering the methods to suit the cow, since the drafting of so many young cows from the breed as bad milkers was not what might be expected from a perusal of their breeding and pedigree records. It was, therefore, decided to work on all heifers before calving in order to accustom them to being milked, and to milk them before calving when necessary, and after calving, to teach them to milk. This process may be briefly described. The heifer is, about 2 months before calving, given a ration of 4 lbs. concentrate per day. Her bag is massaged and she is thoroughly accustomed to being handled. When the flow of milk starts, should her bag need attention, she is milked out each day. After calving she is trained to milk and this training consists of milking her on an average, seven or eight up to a maximum of 15 times in 24 hours if necessary, until she gives

down, and this treatment has been continued for some seven to ten days in special cases as on the heifer Brisoorti."

1009. **Treatment by Sayer on the Brisoorti :**
Here he gives the Table of the treatment to the Brisoorti :

TABLE—93

Treatment on heifer Brisoorti No. 609.

No. of days milked before calving	...	10 days.
Milking hours	...	Morning and Evening.
Average milk-yield during first 5 days	...	1 lb.
"	"	last 5 days
		2 lbs.
No. of days under treatment after calving		7 days.
Milking hours	...	12 times a day.

Milk-yield per day :

1st day	...	5'0 lbs.
2nd "	...	8'5 lbs.
3rd "	...	11'5 lbs.
4th "	...	11 5 lbs.
5th "	...	14'0 lbs.
6th "	...	16 5 lbs.
7th "	...	18'0 lbs.

"She came into normal flush after 5 days from the date of calving.

"The alternative and slovenly method of putting a calf on the heifer, which is practised in many places, is not allowed, as the removal of the calf in the end disturbs the heifer again, while the removal of the man does not produce the same

effect. All the cows in the second and third lactations were treated similarly, and up to 16 lbs. in a day has been drawn out of a cow before calving." He passed on to the case of adult cows.

"At the beginning of this experiment in April, 1932, there were in the herd two well-bred cows—Bulki No. 580 and Algi No. 531—who had passed their second and third lactations, without giving down, and were definitely marked for casting, according to rule, as bad milkers. These two cows were taken over and subjected to the most rigorous handling. At the end of 15 days in the case of Bulki and 8 days in the case of Algi, their opposition was broken and their records are given below as marked against their former lactations."

1010. Algi and Bulki under special handling :

TABLE—94

Lactation figures for Algi and Bulki.

No. of lactations.	Total yield in pound			
	Algi No. 531.		Bulki No. 580.	
I 424	in	69 days' lact.	676	in 89 days' lact.
II 402	„	50 „ „	1,300	„ 117 „ „
III 2,031	„	210 „ „	6,153	„ 294 „ „
				(Figures to date)
IV 5,628	„	304 „ „	...	...
V 3,595	„	170 „ „	...	...
				(Figures to date)

"The lactation of Bulki No. 580 had certain marked characteristics. She varied from 40 lbs.

to 20 lbs. in a day and appeared able to hold back her milk for long periods, but has now reached a condition of steadiness. These two cows are now among the best milkers in the herd."

1011. Calf-mortality and pre-calving milking :

The author then went on to deal with the point of pre-calving milking, owing to which colostrum to the new-born will not be available. He mentioned that in the chain of calvings, some cows might be giving colostrum at that moment, but if not, the calves are fed some linseed oil, and he showed that calf-mortality had not increased. The Pusa herd, it should be noted, was being hand-fed i. e. reared out of contact with the mother.

Calf-mortality figures of Pusa (Pail-fed period)

Period.	No. of calves.	Mortality per cent.
April, 1931 to March, 1932	70	4.3
April, 1932 to March, 1933	69	1.4

"The training of cows and heifers to milk has also been a pronounced success in the majority of cases, and can be recommended for trial in all cases where cows (all other conditions being in order) are not yielding according to expectations. The difference which can be made in the value of a cow or heifer, by this method, is most marked, and the work can be done by any trained *gowala*."

1012. Pregnancy and care of the pregnant cow :

An animal is said to be pregnant when she has a developing young in the uterus. The period of

pregnancy or gestation period is the time which elapses between service and parturition. The cow has a gestation period of 282 days. A schedule is given to determine the date of delivery from the date of service.

CHANGES DURING PREGNANCY: The uterus and the ovaries undergo great changes during pregnancy which subside quickly after the birth of the young. Some alterations occur during the first pregnancy which remain through life, such as the change in the size of the mammary glands and of the uterus. During pregnancy the uterine arteries increase to a great size to cope with the increased work of building the body in the foetus. The inner surface of the uterine wall receives this arterial flow and through the placenta transfers the blood to the foetus. With the growth of the foetus the uterus increases in size and during the later stage of pregnancy occupies the greater part of the abdominal cavity. The characteristic cotyledons of the placenta enlarge and increase in number. These become mushroom-like elevations projecting into the cavity of the uterus.

1013. Signs of pregnancy: When pregnancy has developed, any experienced man can see from the signs that the animal is pregnant. But it is difficult at the earlier stages to say definitely if a cow is pregnant or not. The chief changes are the cessation of oestrus which, if not pregnant, recurs in about three weeks interval. But this is not a sure sign. False oestrus may appear in pregnancy. When a bull refuses to serve a cow in heat, that had been

previously served, this is almost a sure indication that the cow is pregnant already. The temperament of the cow alters; she becomes more tractable and greater calmness comes over her after pregnancy. If after covering she is not pregnant irritability increases. The condition of health particularly improves during the early days of pregnancy, although during the latter period, when the abdomen is largely occupied by the foetus, the opposite is the case, namely, her condition tends to degenerate. The pregnant cow becomes easily fatigued by walk or exercise. A sure test for detection of pregnancy is to splash cold water on the right flank in the morning. If the cow is pregnant for five months or over, the foetus visibly moves under the cold splashing.

As pregnancy proceeds the abdomen continues to become more and more distended. During the latter stage it droops down and hollows appear in both the flanks. The muscles of the quarters appear to fall in, and the haunches and root of the tail appear more prominent. When the root of the tail is left high and both sides sink down, the indication is that cow is going to calve in 2 or 3 days. The mammary glands develop, although in the first few weeks, the glands tend to shrink. If the cow was milking, the milk supply diminishes and when the cow is 7 months in calf the milk supply ceases altogether. There are some cows which may not stop giving milk till the next calving time. But care should be taken to see that after 7 or 8 months she is relieved of the milking, and also that she is better fed. Otherwise, what is

profitable at the moment turns to great loss. On account of losing condition the yield of milk goes down abnormally during the succeeding lactation which cannot be brought up by any amount of feeding. In human pregnancy after, say, six months, the foetal heart sound may be heard with the help of the stethoscope. But in cows, the various sounds and movements in the abdomen generally shut off the foetal heart sound reaching the stethoscope.

1014. Pampering during pregnancy : Excessive attention or pampering during pregnancy can do no good. But care should be taken to see that the cow is in the best possible hygienic condition, and that she is in the best of her health. The food should be perfectly wholesome and devoid of irritants. Unduly laxative substances should not be given. She must have plenty of water. During pregnancy the need for water increases.

During the advanced stage a pregnant cow may be kept separately from others. Vicious cows in the herd may worry and injure pregnant cows. Shocks and injury may cause abortion. If there is an abortion the results are very bad, for an aborted cow does not easily come to heat and keeps on losing condition. It may take two years before she may be pregnant again. Exercise during pregnancy is highly useful, but light exercise only. Without exercise, if the pregnant cow is kept idly to stand or sit all day, difficulty will appear during the time of parturition. Drastic purgatives must be avoided during pregnancy.

From the 7th month onward the mammary glands and udders should be massaged for better performance during the next lactation. As the cow approaches her time of parturition, she should be provided with a thick bed so that in lying down she may not injure the calf in the womb.

1015. Fœtus development during pregnancy :

- 1st stage : 14 days : length of ovum $1/12$ th inch. The fertilised ovum has reached the uterus from the oviduct.
- 2nd stage : 3 to 4 weeks : length of fœtus $\frac{1}{2}$ inch. Traces of fœtus appear and the head and body are discernible.
- 3rd stage : 5 to 8 weeks : length of fœtus $1\frac{3}{4}$ inches. Indications of hoof and claw appear.
- 4th stage : 9 to 12 weeks : length of fœtus $5\frac{1}{2}$ inches. Differentiation of 4 stomachs appears.
- 5th stage : 13 to 20 weeks : length of fœtus 12 inches. Hair appears on lips, upper eye lids and above eye. Teats are visible in female fœtus.
- 6th stage : 21 to 32 weeks : length of fœtus 2 feet. Eye lashes well developed. Hair appears on head and tail.
- 7th stage : 33 to 40 weeks : length of fœtus 3 feet. Fœtus attains full size. Body becomes gradually covered with hair. Claws are complete but soft.

1016. Gestation Table of the cow :

TABLE—95

The average period is 282 days. Male calves come about 4 days late. (Eckles)

Date of		Date of		Date of	
Service.	Birth.	Service.	Birth.	Service.	Birth.
Jan. 1	Oct. 8	May 6	Feb. 11	Sep. 8	Jun. 16
" 6	" 18	" 11	" 16	" 13	" 21
" 11	" 18	" 16	" 21	" 18	" 26
" 16	" 28	" 21	" 26	" 23	July 1
" 21	" 28	" 26	Mar. 3	" 28	" 6
" 26	Nov. 2	" 31	" 8	Oct. 8	" 11
" 31	" 7	Jun. 6	" 18	" 8	" 16
Feb. 5	" 12	" 10	" 18	" 18	" 21
" 10	" 17	" 15	" 28	" 18	" 26
" 15	" 22	" 20	" 28	" 23	" 31
" 20	" 27	" 25	April 2	" 28	Aug. 5
" 25	Dec. 2	" 30	" 7	Nov. 2	" 10
Mar. 2	" 7	July 5	" 12	" 7	" 15
" 7	" 13	" 10	" 17	" 12	" 20
" 12	" 18	" 15	" 22	" 17	" 25
" 17	" 23	" 20	" 27	" 22	" 30
" 22	" 28	" 25	May 2	" 27	Sep. 4
" 27	Jan. 2	" 30	" 7	Dec. 2	" 9
Apr. 1	" 7	Aug. 4	" 13	" 7	" 14
" 6	" 12	" 9	" 17	" 12	" 19
" 11	" 17	" 14	" 22	" 17	" 24
" 16	" 22	" 19	" 27	" 22	" 29
" 21	" 27	" 24	Jun. 1	" 27	Oct. 4
" 26	Feb. 1	" 29	" 6		
May 1	" 6	Sep. 3	" 11		

1017. Parturition : When the foetus is fully developed it operates like a foreign body, and nature endeavours to throw it out of the uterus. The foetus while within the womb gets its nutrition through its umbilical cord which is attached to the placenta.

The cotyledons of the placenta placed on the raw surface of the uterus serve to get mother's blood. Blood comes inside the foetus, circulates through it, nourishes it and carries away excretable products and carbon-dioxide gas through the out-coming portion of the arteries. Thence the arteries go back to the cotyledons. Here the excretable matter and the carbon-dioxide go to the mother's blood, and pure blood enters the feeding artery attached to the umbilicus or navel. The foetal circulation proceeds in this way. When the foetus is fully mature and ready to be delivered out, some irritation happens in the uterus, and there is the urge to expel the foetus out. This is called parturition or expulsion of the foetus, resulting in the birth of the calf. The process of expulsion is a continuous one.

1018. The four stages of parturition : For the purpose of study it may be divided into four stages :

- (1) The preliminary stage ;
- (2) The stage of dilatation ;
- (3) The stage of expulsion of the foetus ;
- (4) The stage of expulsion of the membranes or the placenta.

In the womb, the foetus is enveloped in a mass of saline water, called liquor amni, which is contained in a bag-like membrane. Remaining in this membrane the foetus continues to develop. There is no suffocation although the live creature is immersed in water, because there is no breathing while within the womb. The object of breathing is to purify the blood. The purification of the blood of the foetus is done by the

mother through her circulatory system, as explained above. When the time is ripe there is the tendency of the uterus to throw out the foetus, placenta and all from it.

1019. The preliminary stage of parturition : It may last several hours or even days. About this time the udder swells, becomes hard and tender, and a secretion comes out of itself or on pressing. The external genitals become swollen, red, enlarged and flabby. A straw-coloured mucus is secreted which soils the tail and therefrom the hind quarters. The abdomen droops down and the ligament of the pelvis becomes slackened. The cow sometimes shows excitement and, if free, runs about in an anxious manner.

1020. The second stage of dilatation : The actual and immediate preparation for parturition commences with the second stage or the stage of dilatation. The womb has its opening tightly closed once the male sperm had lodged itself into an ovum, causing fertilisation. Nothing from the outside was to enter the uterus after that. The neck or cervix of the uterus had become thick and plugged with an aseptic material to prevent the entrance of any disturbing bacteria inside. Now, all that is reversed. The cervix of the uterus must not only open but must expand so much that the body of the foetus may come out through it. The opening or the dilatation is, therefore, begun prior to expulsion. The thick muscular ring at the cervix of the uterus is to be thinned out and expanded and, therefore, an expanding and pressing force is necessary.

The mechanism of the water-bag performs this. The foetus is in a bag of water. At the proper moment there is pressure from the body of the uterus. A sort of squeezing motion is generated. The bag holding the water under this pressure is impelled to find an outlet. In the cervix of the uterus a portion of this membrane gets lodged. Another squeezing pressure and a little more gets in, and a thimble-like body is formed filled with the liquor. More pressure on the liquor makes the thimble expand which in its turn expands the opening of the uterus. This force of expansion exerted by the uterus and the consequent expansion cause the labour pain. When this process of expansion or dilatation is going on, the animal is said to be under labour pain. The characteristic of the labour pain is that it is not a continuous one. It comes, exerts pressure, it becomes intense, and then subsides. At every onrush of pain there is fresh dilatation. At the relaxation the animal gets rest and recoups to bear the second onslaught of pain and dilatation.

When a cow is in labour pain she rises up and sits down. Even without examining her, from her painful anxious look and her sitting and rising, one will be able to say that the cow is in labour pain. This process goes on normally till the opening of the uterus becomes as large as the vaginal canal so that from inside to the mouth of the vagina there is one continuous unrestricted passage. The opening is said to be full at this period, to which the second stage had advanced the operation of parturition.

1021. The third stage—expulsion of foetus :

When the opening is ready, another squeeze from the uterus makes the fore portion of the foetus protrude out of the uterus, and the subsequent pushes serve to throw the calf with its membraneous cover more and more forward till the bag and within it the front hoofs of the calf become visible. At this stage the pressure of the fluid makes the membraneous case assume a bulged bag-like appearance which growing in size and hanging from the genitals downwards bursts, throwing off a quantity of liquid and cleansing the passage.

The calf normally comes with the two front hoofs first. Close set on them is its nose. This is called the thin end of the wedge. When the hoofs and nose are at the genital of the cow, the head of the calf is at the pelvis. The head and the withers are to pass the small pelvic opening now. This is the moment of supreme effort and of the greatest point of labour pain. The animal may groan or a heifer may cry out at this stage. The stage is of excruciating pain. The greatest diameter of the calf-body is passing through the narrow pelvic opening, requiring the greatest amount of expansion and the utmost pressure.

At last the force breaks through the resistance of the muscles, and the head of the calf, the thick end of the wedge, comes out. If the cow is standing the head begins to hang down. The rest of the body of the calf is expelled after this, and the calf is born. At the time of birth the umbilical cord, which is short in

the case of the cow, snaps. The separation of the mother from the calf is thereby completed. If the dam is still standing the calf glides down and is deposited on the floor, or if the dam is sitting the calf is slowly pushed out on the floor. When the dam delivers in a standing pose there is the need of an assistant to hold the calf as it comes down, to protect it from injury.

1022. **The fourth stage—expulsion of the placenta:** The placenta and the whole body of membranes at the moment of the delivery were still attached to the uterus. Now is the time after parturition for these to come out. The placenta comes out naturally within a few hours. In case of a weak and neglected cow there is a chance of delay in the discharge of the placenta. The cow has a tendency to eat the placenta. She should be watched, and as soon as the placenta comes out, it should be removed and disposed of—by putting it underground. In the case of delay of over 24 hours in the expulsion of the placenta, veterinary assistance, if available, should be called for. But where it is not available, manipulation should be done by the attendant. The nails of the attendant should be trimmed, the hand cleaned with soap and dipped in a very dilute solution of tincture iodine in water having the faintest iodine tint. Weak carbolic oil of, say, 5% strength, serves the same purpose in addition to lubricating the hand. The hand should be put inside the uterus through the genitals, and the placenta felt at the places it is sticking to on the

surface of the uterus. This should be scraped loose and the materials brought out. After the operation it is better to douche out the interior with a very dilute solution of potash permanganate ; the solution should have the faintest tint. If the delay had been such that putrefaction has begun the cow should be given a few doses of antiseptics in the form of sulphanilamide tablets 10 at a time, and once a day or similar anti-putrefactive preparations. It is needless to say that manipulation by hand should be undertaken as an extreme measure when there is danger in allowing the placenta to remain any longer. Nature should be depended upon as a matter of routine.

As soon as the calf comes out it should be presented in front of the cow. The cow will commence to lick it clean. The naval cord should at this moment be attended to. It should be tied with a piece of a cotton cord soaked in dilute iodine solution, at about $\frac{1}{2}$ inches from the navel. The portion beyond the tied place should be cut off with a clean piece of scissors dipped in iodine solution and a little tincture iodine should be applied with a swab on the cut end. The cut end should be treated with a paint of tincture iodine every day for 4 or 5 days till the cord dries off.

The calf attempts to stand up in a few minutes. It should be helped to do so, and as soon as it is able to do so with this help, a few streaks of milk should be squeezed out of each teat before putting the calf to them ; this will remove any bacteria that might

be in the milk in the udder. The sucking of the teat helps to contract the uterus, which is necessary for the expulsion of the placenta. Sucking by the calf, therefore, helps the expulsion of the placenta.

1023. Care of the cow after parturition : The exterior of the genitals and the flanks and the tail should be washed clean with warm water. If the placenta is delayed, the cow should be watched and the part kept clean with occasional wash with warm water in which a crystal of potash permanganate has been put to render it antiseptic. *Neem* leaves boiled in water make a good antiseptic wash. Such water in a warm condition may be used for cleaning.

The cow should be given a warm drink. Instead of giving simple water, some bran and salt should be added to make it palatable, or still better is the drink of a gruel made of *bajra* or some other cereal or bran, with *gur* and a little oil. The cow should be allowed to rest and some dry hay placed before her to take as she pleased. Some green grass may also be given, but hay would be better. For two days the cow should not be given concentrates except to the extent of making her feed palatable. After this period concentrates should be given and the proportion gradually increased to the full by, say, the sixth day.

1024. Care of the new-born calf : If the mother will not lick the calf clean, then the attendant should dry it clean with the help of bits of clean cloth. If it is cold weather the calf should be warmed by lighting a fire and placing the calf at some distance from it. The calf misses the warmth of the

womb and shall be comfortable in a little warm atmosphere.

The first thing that comes out of the mother's teat is not milk but is called colostrum, a substance resembling milk but loaded with proteins and mineral substances to serve the need of the new-born calf. It is not only strength-giving but it is laxative also. It helps to discharge the accumulated excreta in the stomach of the calf, called meconium. The calf should be allowed to suck up to its needs. In a good milker, if the calf is allowed to drink all the milk, it will die of diarrhoea, for the cow produces very much more milk than what the calf requires or can digest. The calf should be given as much milk as is good for it. The cow should be milked. By milking it can be ascertained how much is obtainable per milking from each teat. From this, an estimate of how many teats should be reserved for the calf can be made.

This is for good milkers. Bad milkers may not give enough for the calf even. The requirement of the calf should be first met.

During the first fortnight mother's milk is the only food for the calf.

1025. Weaning & hand-feeding the calf: In Government military and other farms and in some private farms, there is the practice of weaning the calf from its very birth, and rearing it by hand-feeding. This is the European and American practice, and in this country it is also being recommended. I do not see why the natural relation between the calf and the

mother should be so disturbed that the mother will never know her calf and the calf never know its mother. Where the hand-feeding of the calf and the weaning of the calf at birth is practised, the calf is removed from the mother at the moment of its birth. The eyes of the cow are covered by a bandage or a few folds of cloth so that she may not see her calf. This calf, so taken away, is now brought to the nursery to be reared. Many points are made out for the practice of separating the mother from her calf. The reasons are all economic. The Indian cows are averse to this procedure, and there is no chance of the practice being adopted all over India. The big dairies which may see some good in it may practise it. I do not see any need for it. The calf and its mother must know each other, and the calf should not be denied the mother's affection and the mother should be allowed to suckle it. It is a natural hunger and should be respected. I don't think any saving in milk can be effected by this procedure. The calf will require its quota of milk, whether it is hand-fed or udder-fed. That being so, there is little advantage in the procedure.

1026. Claims for hand-feeding : The advantages claimed for separating the calf from the mother from its birth, and of hand-feeding it, are as under :

(1) In judging the milk-cows the quantity of milk delivered into the pail is taken into account. If any be fed to the calf so much is a loss while the milk-yield of the cow is to be judged, and she is to be registered.

(2) The use of the calf for letting down milk introduces an uncertain item and the calf can be fed more one day and less the next day. The milkers take advantage of this situation and explain away the shortages really due to their negligence or theft by putting the blame on the calves as having stealthily sucked away the milk.

(3) Should a calf die, the cow will refuse to give any further milk, but no such thing can happen in the hand-feeding system.

1027. Claims for hand-feeding not convincing: None of the objections are, however, very serious. As for the custom of recording the milk received only in the pail for judging a cow, it is a man-made rule started in the countries where this system of hand-feeding was general. In India it is different. The rules for judging may be altered. Up to now there has been little judging of the cows. Registration and milk-recording are just being started. Rules can be made providing for an allowance of milk for udder-feeding. As a matter of fact, the hand-fed calves, during the first few weeks, are fed considerable quantities of milk. A portion of what is received in the pail is given to the calf. It is not at all difficult to make an arbitrary allowance of milk for feeding the calves. This should be made and the objection under head (1) will then disappear.

As for (2) the uncertainty of the quantity sucked by the calf and the milk-men's fraud, it is a matter of supervision. If a trustworthy *gowala* is kept, the question will not arise. And for the

millions who milch their own cows it is no problem at all. An unscrupulous milkman can steal even without the calf being there to lay the blame on.

In the case of death of the calf (3), the cow dries up if she was in the habit of being milked with an unweaned calf. It is so. But the death of calves should be a rare occurrence in breeding practice. Weaning, on the contrary, puts a discount on the life of a calf resulting in national loss by the death of calves. In the dairies the calves are regarded as undesirables and as usurpers. Dairy-men for town milk-supply want to get the last drop of milk for sale by depriving the calf. This is a criminal practice, and thousands of calves are allowed to die in this way. The practice of allowing the calf to die cannot be encouraged. Where the calf dies accidentally in spite of the care to rear it in sound health, it should be accepted as inevitable.

There is no case for hand-feeding. Indian cows do not, cent per cent, respond to attempt to milk them without the calf. There are failures, and there are cases of low yields also for milking without the calf. These losses outweigh the chance of loss due to the accidental death of a calf.

1028. Hand-feeding—an imitation practice : If the matter is gone into, there is nothing to recommend it except the fact that it has become the European and American practice to separate the calves from the mothers at their birth for a prospective gain which

is doubtful. In India we do not need to separate the calves from the mothers and pail-feed them from birth.

In India, the Government dairies and some large private dairies are managed by men who have had their training in the western countries or in America where the practice is to pail-feed the calves. The lives of calves are held naturally at a discount when the management is keen on obtaining milk only and not on breeding. There is a Government farm which receives care-takers from the different jail dairies for training. Hand-feeding is practised there and little care is taken of the calves. After such training, there is no wonder that these stockmen become failures when they return to the jails where hand-feeding is not the custom. The careless way of maintaining calves gets into the habit of these trained men, and calves begin to die under their supervision. This matter of holding the life of calves cheap, of regarding calves as useless and burdensome, is the bane of most dairies where hand-feeding is practised.

1029. Saving the calves in hand-feeding : Sayer was keen on saving the lives of calves, although he advocated the weaning of the calves and hand-feeding them from birth. Under his guidance at Pusa calf-mortality became a rare event. Although he advocated pail-feeding, yet the general directions which he gave are useful for calf-rearing. In an article on "The Rearing of Pail-fed Calves," in the "Agriculture & Live-stock in India," July, 1937, he

dealt with the subject. Pusa had men coming to it to get trained in the Pusa system of feeding and handling cattle. Those who were coming for training were herdsmen and supervisors from Government dairy farms. Sayer observed :

"...It has become painfully evident from watching the ideas and methods of many of these men that the science of calf-rearing is one of the most neglected sides of milch-cattle breeding, and while Government spends money freely on staff, stock and buildings, it calmly watches money thrown away by ignorance or neglect of ordinary first principles in calf-rearing. The future of every pedigree herd rests on its calves, and if the calf-mortality is 40 per cent in any herd, that herd is costing about twice as much as it should, to breed quality stock, and a large number of valuable animals bred at a high cost are being lost to Government—the breed and the industry and worst of all, cattle-breeding is being actually taught and demonstrated on some of these farms where such mortalities are common yearly events. ... All that is aimed at here is to give a clear concise account of how to rear an ordinary calf from birth and to keep it in good health and clear from ordinary diseases, until it is able to join the young stock paddocks. At Pusa we had no modern buildings, no special devices or appliances. Our *gowala* staff is probably the lowest-paid in India. They have no diplomas and no training except what they have received here ; but we have a calf-mortality

of 1·6 per cent which is the best diploma of all. Our knowledge of cattle is the knowledge obtained from handling and breeding them, and such knowledge is the best in the world. It is no use having a trained staff and wild cattle any more than a wild staff and trained cattle. Make the staff train the cattle until the cattle can almost train the staff."

1030. Calf-rearing by hand-feeding : "Now, successful calf-rearing begins, though it may not be generally realised, long before the birth of the calf. If your cow or heifer is properly trained, properly handled and properly rationed during pregnancy,.....you will get a state of things at birth which will give you a healthy calf dropped by a cow who is quite calm, normal and in proper condition. She will have been milked out just before and her bag will be easy, and this will avoid a lot of trouble.

"...Directly the calf is out, put a sack over the cow's head and remove the calf. Do this quickly, quietly and efficiently, and it should make no difference if the cow calves at 2 A. M. or 2 P. M. It should be done equally promptly. ..."

"You now have a newly-born wet calf on your hands. Take it to a sheltered place and lay it down on a dry sack ; clean the mouth and nostrils first, and rub the body quite dry with an old soft sack. Trim the navel cord to half an inch and paint it with tincture of iodine, continuing this treatment for 4 or 5 days till the cord dries up. It is quite

unnecessary to tie the navel cord with a string as is so frequently done. While the calf is being dried put your fingers in its mouth (your hand should be clean and the nails pared close) and train it to suck. This is most important, as when the calf comes to suck milk from the pail later, it will do it naturally from your fingers. Never wash a new-born calf; imitate its mother, she licks it dry, and the old sack will do the job perfectly. When the calf is able to move about freely which will be about an hour after birth, give it half a pound of colostrum. Four hours later it can be brought over to the general course of feeding.

"Colostrum from the dam or any other cow calving in the chain is given, as this serves as the necessary laxative to remove the meconium. One ounce of linseed oil for 4 or 5 days at night will have the same effect if colostrum is not available, and the calf is fed on whole-milk from other cows. I might here remark that hardly any of our calves get colostrum from their dams. Most of them get it from cows due in the chain who have several days to go, as all cows and heifers at Pusa are milked out before calving. Calves born out of the chain, i.e. born from a cow calving down by herself at a time when no other cow is near time, never get colostrum but are given linseed oil and whole-milk. Colostrum is not an essential, and such calves under linseed oil made just as healthy animals."

1031. Pail-feeding a new-born calf :

Weight of calf at birth. lbs.		Quantity of milk fed. lbs.
Under 40	...	5 to 5½
40 to 45	...	6 to 6½
45 to 50	...	6½ to 7
50 to 55	...	7 to 7½
Over 55	...	8

"All milk is fed at blood heat. There is no variation to this most important rule, which is the controlling factor in most cases of scouring, etc., in calves. Every week the quantity of milk is increased by ½ pound according to the condition and digestive capacity of each individual calf. They are fed in the beginning thrice daily, 7-30 A.M., 2-30 P.M. and 8-30 P.M. for about a month. This period is prolonged to 6 weeks in the case of weak calves. After a month, only 2 feeds per day are necessary. ..."

"After 6 weeks some fodder, both dry and green, is given to them. ..."

Here Sayer recommends feeding the calves individually from pails, tied at sufficient distance from each other in the open, so that one may not be disturbed by another.

The calves are examined, brushed and looked over while tied to their rings, and thus begins their handling, which is really a closer contact with man.

1032. Sayer's calf-feeding Table : Sayer gives the feeding Chart for ordinary cases. For special

feeding, for early maturity, more food is given according to another Chart.

TABLE—96

Scale of calf-feeding.

Age in week.	Whole-milk. lbs.	Skim milk. lbs.	Grain. lbs.	Salt. oz.
1	8	...	...	...
2	8	...	...	...
3	10	...	...	...
4	10	...	...	...
5	12	...	$\frac{1}{2}$	1
6	12	...	$\frac{1}{2}$	1
7	12	...	$\frac{1}{2}$	1
8	12	...	$\frac{1}{2}$	1
9	8	2	1	1
10	8	2	1	1
11	6	4	1	1
12	6	4	1	1
13	4	4	$1\frac{1}{2}$	1
14	4	4	$1\frac{1}{2}$	1
15	4	4	$1\frac{1}{2}$	1
16	4	4	$1\frac{1}{2}$	1
17	2	6	2	1
18	2	6	2	1
19	2	4	3	1
20	2	4	3	1
21	...	4	3	1
22	...	4	3	1
23	...	4	3	1
24	...	4	3	1

On calculating the amount of whole-milk to be fed to a pail-fed calf, according to the above schedule, for 20 weeks or 5 months, the total quantity of whole-milk recommended to be fed to the calf is found to be 942 lbs. as under :

1st.	4	weeks	252 lbs.
2nd.	4	„	336 „
3rd.	4	„	196 „
4th.	4	„	112 „
5th.	4	„	56 „
			<hr/>
			952 „

If the calves were fed from the udder it is not likely that more than this quantity of milk would be given. Amongst the cows at Pusa some of the noted poorer milkers hardly gave as much milk during their first and second lactation as shown in the case of Algi and Bulki, milk just enough to feed their own calves.

INCREASE IN WEIGHT OF CALVES—A TEST OF FEEDING: The average increase of weight of a calf of the better breed of cows, starting with a 40 to 50 lbs. calf, is 7-9 lbs. per week or a little over one pound per day. This is also Sayer's experience. In fodder-fed calves, if this weight is maintained, then things would be ideal. I have found that under-fed calves also increase at this rate. During the first four weeks the weight increase may be a little deficient, but as soon as the calves learn to digest concentrates, the weight is made up and they

go on adding at the rate of a pound per day, and some put in a little more weight. If pail-fed calves are fed according to the Sayer schedule, it is, I fear, a more expensive affair than if they were allowed to feed from the udder, regulated by the flow of total milk for the time being. From the point of economy in rearing up sound and healthy calves for breeding, pail-feeding shows no advantage over udder-feeding. For those who allow 40 or 100 per cent of the calves to die, there may be saving ; but that is beyond the scope of our consideration, as the rearing of healthy calves should be as much an objective in the dairy as the obtaining of milk.

1033. Sayer allows too much milk : Sayer's prescription for hand-feeding whole-milk is found to be very expensive. Others who have worked in the same field have other quantities of milk for feeding to suggest. The experience and opinion of C. A. Murray, Animal Husbandry Officer of Rhodes, may be mentioned (*Agriculture & Live-stock in India, July, 1935*).

He gave a Table of feeding on which 5 Ayreshire and Friesland calves were subjects of experiment. They were fed 655 lbs. of whole-milk with a concentrate mixture to ensure proper development,

1034. Rearing calves on lower ration of milk :
Rhodes experiments : Another experiment was made to raise calves on a yet smaller amount of whole-milk. In this experiment 408 lbs. of whole-milk were fed to the calves. This amount was fed only up to the 8th week or the first two months of their birth.

After that they depended wholly on hay and concentrates. The conclusion arrived at by the author, Mr. Murray, was that the growth was satisfactory although there was a slight deficiency in weight which the calves were expected to make up later on.

During the first six months of their lives, the calves were fed, as mentioned above, 408 lbs. of whole-milk and 450 lbs. of concentrate and 649 lbs. of hay. In these experiments the calves from the beginning had free access to good leguminous hay and concentrates. Calves generally learn to pick and bite grass from the second week, and from the time that the calves take an appreciable quantity of grass and concentrates the necessity for milk diminishes.

It is necessary to mention that in these Rhodesian experiments the weights of the calves were nearly double those of the Haryana or Sahiwal breed of calves. The batch of calves on which the pail-feeding experiments were demonstrated by Sayer weighed on the average of 8 calves at 47·3 lbs. each. Haryana calves also show about the same weight at birth. In 8 weeks in Sayer's experiment the calves went up to 92·0 lbs. on the average. The gain in weight was, therefore, $92 - 47·3 = 44·7$ lbs. in 56 days or roughly $\frac{3}{4}$ of a pound per day.

In the Rhodesian experiment the average weight of the calves was 78 lbs. against their normal of 90 lbs. In the first Rhodesian experiment the average weight of calves was 86 lbs. against the same normal of 90 lbs. It appears that these calves were normally

double our Sahiwal or Haryana calves. On receiving the 450 lbs. whole-milk in the Rhodesian experiment No. 2, the weight went up in 180 days to 302 lbs. The increase was $302 - 78 = 224$ lbs. in 180 days or $1\frac{1}{3}$ pounds per day against the increase of Sayer's batch of $\frac{3}{4}$ lb. per day. There is room, therefore, to think that in place of 408 lbs. of whole milk in the Rhodesian experiment our Indian Sahiwal and Haryana calves can be brought up on much lesser weight of whole-milk.

In India, calves can be maintained in health with sufficient whole-milk from the mother for the first two weeks only. They may be taught to feed on fodder and concentrates by keeping an older calf with them. They see and imitate and soon learn to take concentrates and grass in small quantities from after the second week. Concentrates and grass should be made freely accessible to them. When they learn to take these, the quantity of milk may be kept on diminishing, and after 8 weeks only a nominal quantity need be fed just to make the cow let down the milk and allow the calf to get the strippings after the milking is done. The strippings are richer than milk. Calves can be brought up cheap and in excellent health and allowed to attain full development in this way, without having recourse to the artificial method of pail-feeding.

Milk from the mother's udder probably has more value than milk from the pail for the calves, because it is seen that very satisfactory results are found by feeding small quantities from the udder during lactation.

1035. Calf-rearing is costly : It does not pay to rear a calf in a dairy. Where the cow is kept for immediate profit to the owner, the calf is a burden. For, whatever be the food upon which you may rear a calf, if you are a dairy-man, you will find that rearing has cost you more than if you had purchased a bull or bullock or heifer or cow, which you want to make from a calf. Then, who are the people who rear calves? Not the dairy men. Those villagers in the interior where milk is cheap, where fodder and labour are cheap and who cannot take the care and adopt the method of milking without a calf, it is they who rear the calf.

This is the case with commercial dairies in India. Those who keep cows for breeding purposes have to rear calves, and their cost is included in the entire cost of the dairy establishment. But commercial dairy owners have come into the business for immediate profit. And they want to maintain that profit. This is the case with commercial dairies not only in India but all over in America and England and in Europe.

References are found in the text books and in the literature on modern dairying, advising dairy owners not to sell off their calves but to rear them at least to meet the requirements of maintaining the strength of their own herds. Evidently they do not do so, hence the advice. They prefer to sell their calves and buy heifers when necessary from other people who are not suppliers of milk to towns. This is the case all the world over. This necessity of obtaining milk at the cheapest rate has led to the invention of the device

and practice of milking a cow without her calf. It is an art, and this art has been scientifically developed in the West not for the health of the calf, not for the better rearing of the calf, but for making the milk supplying dairy more profitable.

1036. Dairy practice and killing of calf : The dairy men in Europe and America calculate that if they rear their calves, they cannot go on indefinitely absorbing them in their own herd ; they would have to sell them, all the males and the excess of females over their replacement needs. This means practically the whole production of calves has to be sold. Selling after rearing them is a losing business. Even if the calves are not reared on their dams' milk but on skimmed milk and grains or so-called milk substitutes, still the cost of rearing them cannot be fetched by selling them. Therefore, the calves are sold for their meat—veal. The dairy makes profit on milk and the calf goes to be slaughtered. There is difficulty here again. The calf, when it is just born, has very much water in its body—near about 75 per cent, and it has only about 25 per cent solid. Such a calf is not liked for veal. Calves must be at least three weeks old to be fit for the meat market. Certain States in the U. S. A. have legislation preventing the sale of calves less than three weeks old for veal. But maintenance, even for three weeks, is a burden. Such a small calf cannot take anything but milk and milk is costly. The amount spent over the milk in feeding the calf for three weeks, to bring up to the standard weight for veal, will be less than the amount received from the sale of it.

Therefore, the calf is allowed to die even without being used as veal. This is the cheapest way of rearing calves—to let them die immediately after birth.

1037. **New-born calves to die:** Eckles in his "Dairy Cattle and Milk Production" (1939) Page 225, put the matter as under:

"Veal Production. Under European conditions where few cattle are kept especially for meat production, veal occupies a decidedly important place in the meat supply of the people. In America, where the abundance and comparative cheapness of feed has made possible the raising of large numbers of animals primarily or exclusively for beef, veal is of far less importance and has not received much attention. In fact, veal calves are merely a by-product of milk production, and the source of supply for a city is, in general, the same herds which supply it with milk. ..."

"Returns in Veal Production. The first question that arises in connection with the veal calf is whether the price received justifies the amount of milk necessary to feed the animal until it can be put on the market. ..."

"Approximately 10 pounds of milk are required for every pound of gain made by the veal calf, but seldom will the selling price of the calf by the pound equal the market value of 10 pounds of milk. Under common conditions every pound of gain (in weight) on a veal calf is made at a loss. The only profit made is by selling the weight of the calf at birth, and it follows that the younger a calf

can be sold as a rule, the greater the profit, even though the total income is less. It is for this reason that the tendency is to sell the calf as young as possible, and that cities and states have found it necessary to establish regulations concerning the minimum age at which calves may be sold for veal. Three weeks is the standard regulation, but it does not prevent many from reaching the market before this age is reached. ..."

1038. American dairy-man and the gowala : We have now probed into the reason of the dairy man's practice of milking a cow without a calf. In this matter, the much-blamed city *gowala* of India is equal to his American and European opposite number. Both work for profit and do not care to rear calves, and are relieved by their death.

Yet calves have to be reared to keep the number of heifers, cows and bulls up to the requirement. Then the question arises as to how best to rear a calf at the minimum of cost and at the same time ensuring its health, so that it may develop into a good animal worthy of the pedigree of the herd.

1039. Calf-rearing on skimmed milk — not practicable in India : It has been found that calves can be reared cheapest on skimmed milk. In calf-rearing, skimmed milk nearly takes the place of whole-milk, if only some grains in the form of gruel are mixed with the skimmed milk to make up for the fuel-value of the butter taken off. Vitamin A also has to be supplied in some form. When the calves are about 2 weeks old they may begin to digest small quantities of hay

or grass providing the vitamins, but for the first two weeks some whole-milk must be given to supply the vitamin in order to ensure the healthy development of the calf.

Use of skimmed milk again presupposes that butter is made in the establishment. In creameries, the suppliers of milk may take back the skimmed milk. In India there is a demand for it as a human food-material so that even if skimmed milk is available in rural homes, calves have little chance of obtaining it.

1040. Calf-rearing on the least quantity of milk : A method, therefore, has to be found out for rearing healthy calves even without the aid of skimmed milk. This can be done by giving the calf the minimum amount of milk and training the calf to take concentrates very early. From after the second week calves can take concentrate and bits of grass or chaff. With older companions it is easy to teach them to do so. After milking, when the calf has had its feed of milk left for it in the udder, a little concentrate, gram husk or linseed cake meal, may be placed on its tongue. It learns to take these, and if these are kept available before it, when in the company of older calves, who take them with avidity, the new-comer soon takes to eating concentrates and hay.

After six weeks the quantity of milk from the udder may be very materially reduced with the corresponding increase in the feeding of gruel, concentrates and hay. After 12 weeks they may subsist entirely on these feeds, getting only the

strippings left after milking and the few earlier suckings just to let down the milk. On this basis milk expenditure need not be calculated after 12 weeks, although in two milkings they will manage to suck from $\frac{1}{2}$ to $\frac{3}{4}$ pound so long as the cow continues to give milk. I have found that a Haryana calf weighing 50 lbs. may be brought up on 300 to 350 lbs. of milk from the udder, and their feeding may yet be so regulated that they go on adding 1 lb. daily to their weight for the entire lactation period and afterwards. (971)

1041. Rearing Haryana calves on 350 lbs. of milk :
The following Table gives an idea of the concentrates and roughages fed to Haryana calves by me for achieving the above result.

TABLE—97

For Haryana calves birth weight 50 lbs.

Daily ration.	A. Calf age 6 weeks to 12 weeks.	B. Calf age 12 weeks to 24 weeks.	C. Calf age 24 weeks to 12 months.
Hay, Straw, Grass.	1 lb.	4 lbs.	8 lbs.
Husks of legumes.	$1\frac{1}{2}$ lbs.	2 lbs.	$2\frac{1}{4}$ lbs.
Cereal, broken rice in gruel form.	$\frac{1}{2}$ lb.	1 lb.	$1\frac{1}{2}$ lbs.
Oil cake, linseed and mustard, equal proportions.	$\frac{1}{2}$ lb.	$\frac{3}{4}$ lb.	1 lb.
Salt.	1 ounce	1 ounce	1 ounce
Bone-meal.	...	1 ounce	1 ounce
Milk from the mother approximately.	$1\frac{1}{2}$ to 3 lbs.	1 lb.	$\frac{1}{2}$ lb.

The quantities put against 6 to 12 weeks are not what a 6-week old calf can take. A batch of calves of that range of age are given the feed. The smaller ones and the beginners take much less and the older ones take more. The ration for a batch of six is weighed out at the rate under A., and the batch feeds together.

Similar for B., the beginners of 12 weeks take less and the older ones of 24 weeks more, but the average quantity of ration fed works out as has been put down.

For C., the batch requires very little concentrate in excess of the B. group. The ration of roughages is increased.

As for milk the 6-week old ones get about 3 lbs., and the quantity diminishes to $1\frac{1}{2}$ lbs. for the 12 weeks old ones. After they have passed 12 weeks, the weaker ones are given a little more than 1 lb. and the stronger ones less and less. For C. group, milk is only nominal, being just enough to make the cow let down the milk, and they are removed from near the cow immediately after the milking is finished.

On the first week of their birth the calves are allowed to be with their dams and 4 times they are allowed to have their fill. Care is taken to see that there is no over-feeding. Excess milk only is taken out of the udders by milking. The first week's full feeding gives a good start. During the second week they are allowed to suck approximately 5 lbs. per day. From the third week milk allowance goes down and down to 1 lb. in the 13th week. A calculated and approximate Table is given below :

TABLE-98

*Milk allowed to Hariana calves on average
in sucking from their dams.*

From the 1st to the 36th week.

(Approximate)

		Daily feed.		Milk fed.	
1st	week	...	...	With the dam.	
2nd	@ 5 lbs.	35 lbs.	
3rd-5th	..	3 weeks	@ 4 ..	84 ..	
6th-7th	..	2 ..	@ 3 ..	42 ..	
8th-9th	..	2 ..	@ 2 ..	28 ..	
10th-12th	..	3 ..	@ 1½ ..	31½ ..	
13th-24th	..	12 ..	@ 1 lb.	84 ..	
25th-36th	..	12 ..	@ ½ ..	42 ..	
36 weeks total				346½ .., say, 350 lbs.	

The milk taken by the calf during the first week is not taken into account because it is colostrum and is not saleable milk.

The health of the calf is watched, and those getting lean are allowed more milk. After 2 weeks they are trained to commence eating roughage and concentrates. Gruel is given from the second week. Those who can forage are given less milk. Linseed cake is the best cake for calves. At the place of the experiment mustard-cake was available on the premises, and because linseed cake had to be purchased half the quantity of cake could be given as linseed cake. The mixture of cakes was made up of half linseed and half mustard cake.

The quantities put against 6 to 12 weeks are not what a 6-week old calf can take. A batch of calves of that range of age are given the feed. The smaller ones and the beginners take much less and the older ones take more. The ration for a batch of six is weighed out at the rate under A., and the batch feeds together.

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On the first week of their birth the calves are allowed to be with their dams and 4 times they are allowed to have their fill. Care is taken to see that there is no over-feeding. Excess milk only is taken out of the udders by milking. The first week's full feeding gives a good start. During the second week they are allowed to suck approximately 5 lbs. per day. From the third week milk allowance goes down and down to 1 lb. in the 13th week. A calculated and approximate Table is given below :

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3rd-5th	„	3 weeks	@ 4 „	84 „
6th-7th	„	2 „	@ 3 „	42 „
8th-9th	„	2 „	@ 2 „	28 „
10th-12th	„	3 „	@ 1½ „	31½ „
13th-24th	„	12 „	@ 1 lb.	84 „
25th-36th	„	12 „	@ ½ „	42 „
36 weeks total				346½ „, say, 350 lbs.

The milk taken by the calf during the first week is not taken into account because it is colostrum and is not saleable milk.

The health of the calf is watched, and those getting lean are allowed more milk. After 2 weeks they are trained to commence eating roughage and concentrates. Gruel is given from the second week. Those who can forage are given less milk. Linseed cake is the best cake for calves. At the place of the experiment mustard-cake was available on the premises, and because linseed cake had to be purchased half the quantity of cake could be given as linseed cake. The mixture of cakes was made up of half linseed and half mustard cake.

It has been estimated that the calves get from the second week about 350 lbs. of milk in total during 36 weeks from their dams. Their feeding is regulated on this basis. The milker can easily understand how much is being left for the calf. With a *gowala* or milkman acting harmoniously with the desire of the management, it is easy to feed the minimum milk consistent with the healthy growth of the calf. This personal method is immensely superior to the method of milking out from the dam and then feeding by hand.

In feeding the concentrates to the calves, it should be remembered that when roughages of a better character are given, less concentrates would be necessary and that legume hay may be regarded as a concentrate by itself. In the experiment mentioned above, roughages consisted of rice-straw and green Guinea grass.

In the feeding Tables for calves the case of Haryana calves has been given. Sahiwals also are of the same weight and require the same treatment. Calves of other birth-weights will require different treatment.

Young calves can successfully be raised on some simple concentrate mixtures ; these have been used with success.

Mixture. I.	Ground maize	...	39 lbs.
	Ground oats	...	40 „
	Cotton seed cake	...	20 „
	Salt	...	1 lb.

Mixture II.	Ground barley	...	200 lbs.
	Ground oats	...	150 „
	Wheat bran	...	150 „
	Linseed cake	...	50 „
	Bone-meal	...	4 „
	Salt	...	3 „
Mixture III.	Ground maize	...	34 lbs.
	Ground oats	...	35 „
	Cotton seed cake	...	20 „
	Dry skimmed milk	...	10 „
	Salt	...	1 lb.

1042. Birth-weights of calves : In the matter of feeding, the birth-weight of calves has an important bearing. Calves at birth may be weighed and their actual weight determined. It is necessary to find out whether the calf has been born with the normal weight or not. The normal birth-weight is regarded in India to be 5 per cent of the weight of the dam.

Macguckin gives the formulas which depend upon the consideration that the calf is influenced 2 units by the dam and 1 unit by the sire in the matter of birth-weight. According to him the birth-weight of a calf should be 5 per cent of the average weight of those 3 units.

$$\frac{\text{Weight of dam} \times 2 \quad \left\{ \begin{array}{l} \text{Weight of sire} \times 1 \end{array} \right.}{3} = A.$$

A. divided by 3 is the average of the weights of the parents. 5 per cent of this weight or one-twentieth of it should be the normal weight of the calf.

Modern American opinion, however, is that the birth-weight of the calf depends solely upon the weight of the dam and is unaffected by the weight of the sire, probably if of the same breed. We calculate 5 per cent or $\frac{1}{20}$ th of the weight of the dam for the birth-weight of the calf in India. The American calculation for normal weight has been found to be different with different breeds as under :

TABLE—99

Breed.		Average birth-weight of both sexes.	Weight of calf in proportion to weight of dam. Per cent.
Jersey	...	55	6·3
Holstein	...	89	7·8
Guernsey	...	71	7·1
Ayrshire	...	72	7·3
Brown Swiss	...	100	8·9
Dairy Short-horn	...	73	6·0

The normal birth-weights of the different Indian breeds and their percentage to the weight of the dam have not been worked out in a tabular form. It is expected when the normal birth-weights of Indian breeds are worked out, similar variations as are shown in the above American Table will be found. In the meantime 5 per cent of the weight of the dam may be regarded as the standard for calculation of the normal birth-weight for the Indian calf.

1043. Rearing heifers : Female calves, after their dams cease to lactate, cease to be called calves and are

called heifers. The rearing of a heifer is the rearing of a future cow.

FEEDING: The feeding rate of calves for six months from 6 to 12 months of age has been given. That feeding is based on poor roughages, as has been mentioned, of rice-straw and about 20 per cent Guinea grass. The concentrates have been suited to this poor roughage. If better roughage is given, correspondingly less concentrates will serve. (971)

1044. Heifers from 6 to 12 months age: Morrison recommended the following for this age of calves:

"The amount of concentrates required will depend on the quality of roughage fed. With good roughage 2 to 3 lbs. of concentrates per head daily should be enough; while, with that of only fair quality 4 to 5 lbs. may be needed to keep the heifers gaining properly. Heifers 6 to 12 months of age should be fed 8 to 15 lbs. of hay per day or 5 to 10 lbs. of hay and 8 to 15 lbs. of silage."

This is for American cows. Of the American cows Jerseys correspond closely to the size and weight of our Harianas. Therefore, the above observation will be applicable to the Harianas also. Judged from Morrison's standard the ration indicated, in column C., providing $2\frac{1}{2}$ lbs. of concentrate with $2\frac{1}{4}$ lbs. of legume husks, a second-grade concentrate, and 8 lbs. of roughage in Para 1041 seems to be fair, considering our climate, with less need of roughage in consequence. In practice, the scheduled quantities have been found to be satisfactory.

Pasture, and good pasture at that, is strongly recommended. If the pasture is excellent no concentrates would be necessary to bring up healthy heifers to their full development.

After the heifers have become a year old, their capacity to eat roughage increases and they need less and less concentrates, taking the character of the roughage into consideration. If they are fed on rice-straw or wheat-straw, as the main roughage, the need for concentrate will fully remain. With *joar* or *ragi* and green fodder or silage in plenty, the necessity of concentrates will be less, and if they are fed a portion by pasturage on Lucerne or Berseem, no concentrate will be necessary. Lucerne and Berseem green pasture will take the place of concentrates.

1045. Age for first calving : In America they call calving at the age of 24 months to be fair maturity. For this, the calf is to be served by a bull in its 15th month. If the first coming to heat is delayed in America to 16 or 18 months, it is then often considerably difficult to have a heifer heated.

In India calving at 24 months is rare. Early maturity experiments at Pusa showed that it can be successfully achieved without any bad effect on the weight of the calf or on the constitution of the heifer.

In order to find whether a heifer is making fair progress, it is necessary to find out its weight. For a Haryana calf, properly developing into a heifer, the rate of one pound increase of weight per day on the average up to the second year may be regarded as fair.

1046. Jersey heifers : Table of weights :*TABLE—100*

*The weights of Jersey heifers, given by Morrison
as normal, are as under.*

Months.		Weight.
Birth	...	54 lbs.
1	...	68 „
2	...	92 „
4	...	164 „
6	...	250 „
8	...	331 „
10	...	402 „
12	...	462 „
14	...	518 „
16	...	568 „
18	...	615 „
20	...	658 „
22	...	702 „
24	...	750 „

In bringing up heifers, care should be taken to see that they do not get too fat. Fatness and over-feeding delay their coming to heat. Feeding is an art and should be learnt from experienced men. The Tables can only serve as aids and guides. But absolute dependence on Tables would be disastrous, as these can never tell all that need be told in the matter of constructing a ration and feeding for animals.

1047. Lactation yield with advance in calving :
The first lactation of a heifer is below what her

normal and full capacity is. In the second lactation also the yield does not generally come up to the full. From the third lactation full yield is obtained which is maintained up to the sixth and beyond according to circumstances, after which the yield decreases.

1048. Rearing bull calves : The general lines will be the same as indicated for heifers. After the calves have attained 6 months they should be separated from the females, because the bull calves make quicker gain than females. In America, a bull, if well grown, should be sufficiently mature for very light service at 10 to 12 months of age ; but not more than 1 or 2 services in any one week should be permitted until he is 2 years old. In India we may limit the age by adding 6 months over the American standard, and take full service from a bull after its attainment of $2\frac{1}{2}$ years, although light service can be taken from $1\frac{1}{2}$ years. Sayer's experiments have dispelled all fears about the unsuitability of early maturity in male calves. (971)

1049. From calf to mature bull: The bull should be broken as a calf and at about 1 year of age should have a stout ring inserted in its nose. The ring should not be allowed to wear thin. At the age of $2\frac{1}{2}$ years the ring should be replaced by a larger one.

The bull calves should be so handled that they come to feel that man is their master and should never be given an opportunity to learn what great strength they have. (964) Stalls and fences should be so built that they may never break through these, so that they may not learn how to break loose. A bull should be handled

with a strong rope attached to his nose ring. A staff attached to the nose ring would be better. Remembering that fatal accidents happen in handling the bull, safety will lie in always being alert when handling them. Nearly all the accidents have been with 'quiet' bulls that have been too much trusted is Morrison's warning.

Some work should be given to the bull, and he should be trained to the work quite early. Pulling of carts singly harnessed is one way. Better would be to give him a steady work such as driving a *ghani* for only a short period daily. This will keep him in a fit condition. Without work and on idly eating, the bull gets impotent early and his disposition also becomes ugly.

1050. Number of services in the year : 60 services can be taken during a year. 100 services also will be fair if they are evenly distributed.

CHANGE OF A SIRE : The bull, if kept for more than 3 years in the same herd will in-breed. The practice, therefore, has developed of exchanging bulls between establishments. If a bull is a good one and if his daughter is a good milker he may be allowed to stay on. This matter has been discussed while considering breeding.

1051. Castration : Male calves should be castrated at 6 months of age. They may be castrated later on also. But it is safer to castrate an animal before it attains the age of serving a cow ; for only approved bulls are to be engaged for service. Uncastrated bull-calves are a danger to proper

breeding. In order not to run risks, such calves as are not to be reared as bulls, should be castrated within 12 months of age.

For castration a 'Burdizzo castrator' should be used. This is more or less painless and there is no danger of sepsis. The difficulty with it is that the cord may slip from its grip and the castration may not be perfect, allowing some blood to pass, in which case the calf will continue to function imperfectly. As a safety, therefore, both the cords are separately crushed, each in two places, one below the other, so that during the second castration no pain is felt.

After the crushing, the scrotum and the testes also swell. The swelling remains for a few days and then subsides, and there is atrophy of the part which shrinks in size.

1052. Feeding the bullocks : The bullocks should be fed according to the work taken out of them. The maintenance ration has been given for the weight of the animal. For work additional nutrient has to be supplied. Nutrients required for work production per 1000 lbs. body-weight have to be added to the maintenance allowance.

TABLE-101

(Based on Armsby's data by Sen.)

Work.	Digestible protein. lb.	S. E. (Starch-equivalent)
Heavy (8 hours work a day)	1.5	13.12
Medium (4 hours a day)	.9	6.56
Slight (2 hours a day)	.5	3.29

For maintenance, the general computation for a 1,000 lbs. weight of animal is 6 lbs. starch equivalent and .6 lb. digestible protein.

It will be seen that for medium or 4 hours work as much starch equivalent is needed as for maintenance, and the protein requirement is over double the scale for maintenance. This is from Armsby's calculation. Now a days, it is regarded that the protein requirement assessed by Armsby is much too high. On the other hand, the theory that protein is required only for maintenance and not for work is not borne out by actual test. In actual test animals do require protein for work. Therefore, between allowing no protein and giving as much protein as was tabled by Armsby, there is a middle path. This middle path will point to the feeding of double the maintenance ratio for 4 hours work, in other words, feeding double the maintenance proteins and double the maintenance starch equivalent.

It will be observed that all this new energy and protein have to be supplied from concentrates, because we have allowed all the grass that an animal can take for its maintenance. There is no room left for fresh ingestion of roughage for the production of work. If, in any estimate, nutrients for work are to be provided, such nutrients must practically come wholly from concentrates in quantities set forth in the Table. In other words, both proteins and starch equivalents should come from concentrates.

Without foods containing protein, the extra ration becomes unpalatable, and palatability does not respect scientific boundaries. The working animals have to be given proteins in the form of concentrates.

If roughages are increased and the animal can digest the increased quota of roughage, still the new roughage will not go to produce work, because of the energy consumed in masticating it. In maintenance such dissipation of energy gives rise to heat which maintains the body. But where energy is required the dissipated heat cannot give that. The necessity of providing extra energy in the form of concentrates becomes almost imperative.

As a general rule, therefore, feeds should be supplied for work in the form of concentrates containing a fair proportion of protein as given in the Table.

1053. Management of the dairy cow: By scientific management great improvements in the milking capacity of the cow may be accomplished. Research was done on this subject and on the subject of early maturity and skeletal improvement of bulls and cows etc. at Pusa and elsewhere. In the following paragraphs the work done on the Sahiwal cow is described as an object-lesson.

The accompanying Table will show what improvements the Lyallpur (Punjab), Pusa (Bihar) and Ferozepore (Punjab) farms brought on the Sahiwal.

1054. Progressive increase in milk yield by herds at Lyallpur, Pusa and Ferozepore: From the date of their establishment.—(*Wright's Report*. P. 172).

TABLE-102

Average daily yields in lbs.

	1914	1912	1912	
	Lyallpur.	Pusa.	Ferozepur.	Overall.*
1st year	5.60	5.8	11.3	4.6
2nd "	5.40	7.6	11.6	5.9
3rd "	6.80	8.3	12.9	8.6
4th "	7.18	6.6	12.9	9.2
5th "	7.45	6.8	12.6	9.8
6th "	8.60	6.1	14.8	10.6
7th "	9.31	7.4	14.7	11.3
8th "	7.27	8.2	15.0	11.1
9th "	9.10	8.0	16.2	11.9
10th "	9.30	9.4	16.4	11.7
11th "	9.03	10.8	17.4	12.5
12th "	9.8	12.0	16.4	12.1
13th "	11.28	12.3	15.3	9.9
14th "	10.73	11.7	18.0	12.5
15th "	11.97	12.7	17.0	12.5
16th "	11.40	14.3	15.4	12.0
17th "	11.67	12.4	16.9	12.9
18th "	12.82	13.0	17.7	12.8
19th "	11.43	13.6	20.3	17.0
20th "	15.05	18.5	22.6	16.8
21st "	16.54	...	18.3	13.7
22nd "	17.15	...	16.5	11.1

* "These are over-all averages, i.e. averages over milking and dry stock, whereas those shown in other columns are milking averages. Further the progressive increase of the Ferozepur herd is often masked by the influx of fresh cows which are purchased in the market for meeting the requirements of trade. These are not separately shown."

A look at the fore-going Table will show what enormous progress has been made in course of 22 years. The Ferozepur herd had a better start i.e. it began with comparatively high-yielding cows. While Lyallpur and Pusa began with about 5·7 lbs. daily yield, Ferozepur began with 11·3 lbs. To come to Ferozepur's starting yield of 11·3 lbs., the Lyallpur and Pusa herds took 12 years. In Olver's words, Pusa and Lyallpur doubled their yield in 12 years. Once a high mark is reached it is not possible to keep the same rate of progress in the milk-yields of herds. Further improvements must necessarily be slower and slower. Another 10 years were required for the Lyallpur and Pusa herds to put in another 5 lbs. of milk per cow per day for the herd, bringing the daily average to about 17 lbs. The Ferozepur herd, starting with 11·3 lbs. of milk, also put in another 5 or 6 lbs. in 11 years, reaching 17 lbs. It has gone up to 18, 20 and even 22 lbs., but the results have not been steady ; for, after attaining 22 lbs., it fell in 3 years to 16·5 lbs. It may be due to the purchase of fresh cows from the market—cows having comparatively poor yield—or it may be due to a fall for reasons within the herd.

The Table shows us what the Sahiwals under expert management can do. The opposite of this will be found when we come to study the performance of the same Sahiwal in the hands of the villager. (263)

The improvement achieved in the dairies at Ferozepur, Lyallpur and Pusa is due to the number of successful experiments conducted. The achievement

was not due to routine procedure. Every dairy-herd was made a laboratory-subject of experimentation, and an amazing amount of imagination, technique and skill was brought to bear on the subject of research. Some of the published reports of experimental work of Mr. Wynne Sayer with the Sahiwal herd at Pusa (Bihar) are too instructive to be passed over. (263)

1055. The Sahiwal at Pusa : There was a common belief that service from mature bulls only should be taken, and that the heifer also should be mature when she takes the bull, so that a sound progeny may result. This accepted belief was being worked upon. The cattle in India come to maturity much later than they do in Europe. Because of late maturity of service time and of calving time, there is economic loss. Apart from these, those who want to make genital experiments for the improvement of the herd have to wait much longer than they would have to do otherwise. These factors led Mr. Wynne Sayer to start experiments with the Sahiwal herd at Pusa at his disposal.

He made innovations, and thanks to his researches, we now know that under proper management early maturity gives very satisfactory results. The usual way for judging a bull is by mating it and then seeing what milk the daughter of the bull gives as compared with the milking capacity of her dam. The time usually required for carrying out such an experiment covers a period of five and a half years only in England ; whereas in India, such an

experiment would take close upon nine years. By that time the bull to be tested will have grown old and of little service. The usual Time Table is given below. (72, 258-'63, 1061)

1056. Age of a proven bull in England and India :

TABLE—103

	In England.		In India.	
	Year.	Months.	Year.	Months.
Age of bull when it				
first starts service	1	6	3	0
Calf is born at	0	9½	0	9½
This calf becomes a				
heifer and receives				
the bull at	1	6	2	6
Gestation period	0	9½	0	9½
End of first				
lactation.	0	10	0	10
End of second				
lactation.	...	...	1	0
	<hr/>		<hr/>	
	5	5	8	11

In the first lactation the full milk-yield is not reached in India ; therefore, a second lactation has to be taken before the performance of the bull is proved. From the above Table, with early maturity, a bull in England can be proved in 5½ years as against 8 years 11 months or, say, 9 years in India.

“The experience at Pusa where we have rigidly refrained from the policy of merely purchasing all

the best examples of the breed which could be found (which is not really cattle-breeding) has been as above in almost all cases, and to say that it has been one of the chief obstacles to the work of milch improvement is to state nothing but the plain facts. During most of the time we have been using bulls of unknown value, with the result that we have had a few pleasant surprises and a good many severe shocks, and progress has been slow." (72)

1057. Goal of 1,000 gallon herd-average : "It had, therefore, become clear that if the Sahiwal herd was going to progress by its present method of breeding up towards the goal of a 1,000 gallon herd-average (which is the aim of the first-class milch herd) then this work had got to be accomplished by the use of tested and proved bulls only. It must never be forgotten that the higher you bring up the milk-average of your herd, the easier it is to find a bull which will bring it down. It is much easier to depreciate the progeny of a 1,000 gallon cow than a 500 gallon, and this rule holds good and becomes increasingly significant as the herd-yield increases." ("Pusa Early Maturity Experiments"—Sayer. *Agriculture & Live-stock in India*. November, 1938).

The Pusa herd, thought Mr. Wynne Sayer, had reached a stage where it was definitely inadvisable to use unproved bulls, and it became essential "to develop early maturity which is a marked feature of successful cattle-breeding work in England."

The experimenter then took to better feeding the bull and the cow-calves to induce early maturity. He gave whole-milk to the calves in large quantities and for longer periods than was usual. By this and other attention to details of management he succeeded in bringing the calves to early maturity. The new calves quickly put on more and more weight. They developed in 18 months the size and weight which they usually attained at 24, a clear saving of 6 months to start with. Both male and female calves thereby matured early.

Lakham No. 568 and *Bisoon* and *Nalu* started service at one year seven months to one year eleven months age. The calves thrown by these early matured bulls were quite up to the standard obtained in the herd previously. There was no diminution in the weight of the calves. (72)

1058. Early maturity bulls and heifers : The early maturity bulls were made to serve three classes of cows

1. Old cows.
2. Heifers allowed to stand over until $2\frac{1}{2}$ years of age, according to the usual practice.
3. Early maturity heifers.

In case of (1) and (2) there was no definite lowering of the weight of the calves at birth. In case of No. 3, using an early matured bull on an early matured heifer, the weight of the resulting calf was less than normal for the herd. But this was what had been expected. It is against breeding practice to use an early maturity bull on an early maturity calf. The

rule is to use an early maturity bull over old cows and an old bull on early maturity heifers. Yet in this experiment, although the calf was under-weight at birth, it grew up to full weight. In the case of *Lagati No. 633*, the sire was one year and eight months old at the service time and the dam was one year ten months and eighteen days. The calf was light in weight at birth, but later on became perfectly normal. It is necessary here to point out that birth weights have very little bearing on the ultimate size of the animal, subject to breed-average. (72)

1059. Early maturity—a success : Mr. Wynne Sayer has given a series of figures about the early maturity experiments, and there is no doubt that the experiment was a success. He observed :

“...I may here remark that our finest heifer-calf is an early-maturity both sides, and her mother was covered at one year one month and twenty-nine days...while the bull was two years nine months and five days old, and had been serving since the age of one year seven months and twenty-seven days.”

Early maturity has no bearing on milking quality which is an entirely different factor.

“As regards the utility aspect which was the original reason for the start of these experiments, the following cows’ history may be taken as representing the difference in utility period shown by early-maturity as against the normal methods. The four old cows shown...are the pick of the herd, all having done over 8,000 lbs. in ten months. (72)

1060. Table of cows under usual and early maturity experiments :

TABLE - 104

History of cows under old regime and early maturity experiment.

Name & Brand No. of cow.	No. of calvings.	Age at calving.	Milk yield per lactation.	Remark.
<i>Cows under old regime.</i>		Y.M.D.	lbs. Days.	
Chendrama No. 569	1	2 10 28	3,077 306	...
	2	4 4 8	3,878 304	...
	3	5 4 11	6,604 308	} Special handling lactations.
	4	6 4 13	6,029 304	
	5	7 6 0	8,015 306	
Chakai No. 563	1	3 5 25	1,255 271	
	2	5 1 6	5,957 304	do
	3	6 3 4	6,899 306	do
	4	7 3 19	8,001 304	do
Makhi No. 557	1	2 11 4	2,994 308	
	2	4 3 18	5,478 308	
	3	5 5 19	7,228 306	do
	4	6 5 17	7,082 306	do
	5	7 4 25	8,049 306	do
Ramati No. 566	1	3 11 9	5,066 306	
	2	5 2 13	8,863 304	do
	3	6 3 10	8,327 304	do
	4	7 3 5	6,001 308	do
<i>Cows under early maturity experiment.</i>				
Birengee No. 681	1	2 3 25	3,744 304	do
	2	3 6 29	6,361 304	do
	3	5 0 0	... ...	giving 81 lb. per day.
Chaprama No. 676	1	1 11 8	4,306 304	} Special handling lactations.
Chansuri No. 658	1	2 7 29	7,686 304	
Brukta No. 654	1	2 8 12	8,978 307	

From the above Table it will be seen that the early-maturity heifers are in no way inferior to the average of the best producers of the herd. *Chaprama 676*, calving at the age of 23 months and receiving service $9\frac{1}{2}$ months earlier at about 14 months of age, gave in her first lactation 4,306 lbs. This proves the success of the early-maturity experiments.

Mr. Wynne Sayer has made no secret of his methods of bringing in early-maturity in calves by better feeding and rearing.

The above Table brings out another result of the experiment. In the remarks column will be found that cows in some cases had special handling. And invariably in those cases the same cow showed remarkably higher yield after the handling. For example, the first name in the list, *Chendrama*, in her first and second lactation, gave about 3,000 lbs. of milk. In the third lactation she received special handling and the milk out-put doubled, having reached over 6,000 lbs. Similarly, *Makhi* increased from 5,478 lbs. to 7,226 lbs. *Ramati* showed still further improvement, having gone up from 5,066 lbs. in the first lactation to 8,863 lbs. in the second lactation on special handling. Undoubted improvements have been worked in the Sahiwal cows of Pusa by special handling. (72)

1061. Special handling of the Pusa pedigree—Sahiwal herd: Special handling is a special treatment meted out to the calves by which they come to regard men and attendants as friends and give up all shyness. They are fed artificially the most nutritious diet,

whole-milk in the earlier months and then a mixture of whole-milk and skimmed milk along with the roughage. The heifers are made accustomed to massaging their udders and take such handling as nothing extraordinary. They get accustomed to the approach of, and the handling by, new men without resentment and terror. In addition to the square food that they receive, the cows are milked 4 times a day.

Mr. Sayer wrote :

“Handling in this reference is a general term and does not solely apply to massaging the udder nor to any special treatment just before calving. Milch stock should be handled from birth.”

Calves at birth are removed from the cow, and after being dried and the navel cord treated with antiseptics, they are taught to drink colostrum from a bowl. At the age of a few days each calf is tied up to a ring on the floor and fed from a bowl. It, therefore, learns from the very start of life to stand still when tied up and is accustomed to get a rope or halter, and being fed at such times as it is tied up. (72, 258-'63, 1055)

1062. Starting life with milch temperament :

The ring-space method of tying calves for feeding enables each calf to be carefully examined at any time by any body and to become absolutely used to all forms of handling, so that by the time they are 10 months old and is due to be sent to the young stock enclosures, they are absolutely tame and can be handled freely by any one. It has, therefore, started life with a *proper milch temperament*. All young

heifers are allowed to run in a bunch for grazing and are never tied up. They are looked over every day, and any heifer, requiring examination, is led up by the *gowalas*. All heifers are weighed once a week.

No *gowala* or herdsman is allowed to carry any form of stick or switch. As a result all cattle move slowly and there is no confusion. The only sticks allowed in the cattle-yards being the bull sticks ; all the men carry brushes and carry combs instead : they work their combs on the animals in the field while grazing. This assists to remove the ticks, also "ticklishness."

1063. Special treatment of heifers : "When the heifer comes on heat, if she is over 500 lbs. and eighteen months of age, she is covered and then goes back to the bunch. When she is about seven months on, she is given an increase in ration from 2 to 4 lbs. per day (first pregnancy ration) until about two weeks before calving when she receives 6 lbs. concentrates per diem. About a fortnight before date she is taken into the calving enclosure and the handling or massaging under the system is started. Directly she shows a bag she is worked on and milked slightly. This massaging and milking continues until she calves down."

1064. Pusa : special treatment on calving : "In all cases where she has a big show she is milked out to avoid any inflammation or pressure on the bag and this is one of the principal merits of pre-milking. ... Seven to fourteen pounds have been taken freely out of a heifer with a big show. Directly she calves

down, the calf is removed and she is then milked out every two hours to bring her down to full flush. This period of intensive milking varies ; some heifers come down at once, others take several days, but if the milk is there she will let it down under this treatment, and once started will milk out freely. To show the efficacy of this treatment, we have an 8,000 lbs. cow now in the *byre* in her fifth lactation. She is a naturally shy cow and has had to be handled very carefully to get her to the present pitch. As a heifer she did only 1,200 lbs. in her first lactation, because she was very nervous and shy and had not been properly handled from birth. Our present methods, therefore, could not have been applied immediately to her."

1065. **Skeletal changes on the quality of the Sahiwal :** Mr. Sayer's experiment on the Sahiwal continued in newer fields. In his work in the Sahiwal herd, it became evident that he was up against several difficulties besides that of milk-yield. He visualised that the Sahiwal was one of the best milch-breeds of the world, and satisfaction could come to him only when the obstacles to the Sahiwal rising up to that position were removed. He conceived the idea that some structural alterations were necessary to bring the breed in line with the world's best.

1066. **Difficulties of special treatment for skeletal change :** The first difficulty about the Sahiwal male-stock was that they became sluggish at an early age, and to a great extent impotent in latter life. This was a great draw-back. And Mr. Sayer set about to bring

about the necessary change in the conformation of the Sahiwal. He spotted the fault to be due to the loose sheath. An idea was prevalent that loose sheath was connected with high milk-yield. He disproved that, and succeeded in transmitting tight sheath to males. For three generations tight-sheathed animals were bred, the milk-capacity was tested, and it was found that a tight sheath does not inhibit milk. The udder of the Sahiwal was another feature which required improvement. It hangs down like a pitcher. For the Sahiwal to be a first-class milch-cow, an improvement of the udder was necessary. The reason of the particular shape of the udder was the dropped rump of the breed. It was necessary to find a bull who would enable the top line to be straightened and so improve the udder. Mr. Sayer has been successful in carrying out the desired alteration in the structure of the Sahiwal, and in improving the udder without impairing the milking capacity.

1067. The place of the Sahiwal in world milk-record : The Sahiwal is now on the march for taking a position in line with the best milkers of the world. She has shown in several instances a record of 14,000 lbs. of milk in a normal lactation of about 300 days.

In the Punjab itself Major C. E. Macguckin, Assistant Director, Military Dairy Farms, Northern Circle, has been doing much original work on the improvement of the breed, specially contributing to the building up of the constitution necessary for high-milking capacity.

CHAPTER XXIV

MILK SECRETION AND MILK

1068. **The mammary gland :** The udder of the cow is a gland called the mammary gland. The gland manufactures milk out of the elements carried to it by blood through the mammary artery. This artery sub-divides itself into a number of smaller arteries, which carry blood to every part of the mammary tissues and to the secreting cells.

The mammary gland in rudimentary form appears in the foetus even when it is two or three weeks old. This gland grows slowly after birth. When puberty is reached the growth of the gland becomes rapid and continues up to the time of lactation. The udder increases in size, and very complex internal structures appear. Up to the last stage the formation of the milk secretory cells is held up.

The gland is divided into four separate compartments each of which is called a quarter. There is a teat attached to each udder, which has in its turn a small cistern attached to it called the milk cistern with a capacity for holding about an ounce of milk. The cisterns are fed by milk-collecting ducts. These ducts branch out again into smaller and smaller ones till at the end of the branching process, the tiny ducts enter into little hollow spherical structures lined by a

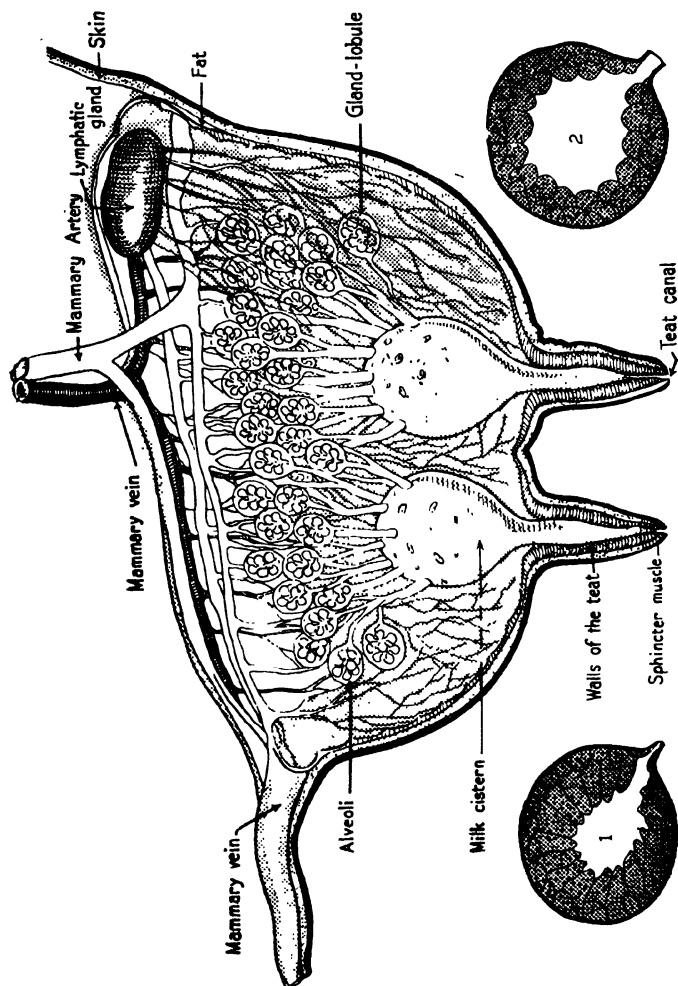


Fig. 49. Schematic figure showing sections of the cow's udder.

1. Alveolus, enlarged when laden with milk.
2. Alveolus after discharge of milk.

(Indian Farming., Vol. IV, No. 4)

single layer of cells. The cells of the mammary glands secrete the materials of the milk solids without themselves breaking down. These cells, amongst themselves, do all the conversion of blood to milk.

The whole of the blood is not used in constructing milk out of it. Blood consists roughly of two substances, the plasma and the corpuscles. The corpuscles settle down on keeping blood in a tube for sometime, and a straw-coloured fluid separates out which is called the plasma. Researches indicate that the corpuscle portion of the blood makes little contribution to the direct formation of milk, the plasma substance is converted into the various constituents of milk. Science has not probed into the exact process of milk formation. It is still a mysterious fluid to the scientist, a fluid having the highest potency for maintaining life. It is estimated that 400 lbs. of blood must circulate through the udder for every pound of milk. What a torrential flow must be passing through the udder of a cow which gives, say, 12 lbs. of milk each 12 hours ! 400 lbs. of blood must be passing through the udder of that cow every hour or about 7 lbs. per minute.

The capacity for carrying blood must be large for the milk artery, and also for the milk vein to carry away the remnant material after the formation of milk. As 400 lbs. of blood have to participate in making a pound of milk, the contribution per pound of flowing blood to milk is very little indeed, so that the return blood get

denuded to the extent of $\frac{1}{400}$ th. of its contents only and, therefore, apparently the return venous blood from the udder is not much different from the ordinary venous blood. The milk vein must be particularly large to be able to carry away this large outflow of blood.

The milk vein can be seen as a prominent crooked line on the udders. The breeders examine the milk vein in order to judge about the milking possibility of a cow.

1069. Milk formation : It was held by some that milk can be secreted at the time of milking the cow. The contrary hypothesis that milk is secreted all along, and that it is the stored milk in the udder which is emptied out, is accepted by physiologists who say that the quantity of milk obtained at a time must have been stored in the udder.

The cow has control over the milk-flow. The nerve system in the udder gives her that power of control. If she wants it, she can withhold formed milk from being milked out. Even during milking she can withhold some milk for sucking by her calf. This is taken advantage of by allowing the calf to suck after milk has ceased to flow. When the calf is sucking she allows milk to come down again. When milk is let down a second time for the calf, she can be milked again at the same sitting. But this should be done when the calves are more or less independent of the milk of their dams and have learnt to eat concentrates and fodder in appreciable quantities.

1070. Sugar-contents of milk : Milk contains various specific substances like milk fat, milk sugar or lactose, proteins, minerals and vitamins. These are made out of blood by the powerful and selective cells of the mammary gland.

The milk-sugar portion of milk is contributed by the milk-sugar of the blood. There is a relation between the level of blood-sugar in the blood and the level of milk-sugar in the milk.

1071. Milk proteins : Milk contains three proteins—casein, lactalbumin and lactoglobulin. Casein is present in the largest quantity. Casein does not occur in the blood. The glands probably take up the proteins of plasma and synthesise casein out of it. Lactalbumin is derived similarly. But lactoglobulin is derived directly from the blood stream. It is very largely present in colostrum, to the extent of 10 to 15 per cent. This ingredient diminishes as colostrum changes and takes the character of milk. In milk it very nearly disappears, being only 0.1 per cent. From this, the suggestion comes that it is lactoglobulin that ultimately makes the two other proteins of milk, casein and lactalbumin.

1072. Milk-fat etc : The mammary gland manufactures the fat also from the plasma. Milk-fat is a complex mixture of fatty acids, quite a number of which is present in the final product.

The *minerals and vitamins* which are constituents of milk are taken directly from the blood stream into the milk.

1073. **Milk-secreting hormones :** It has been mentioned that cows feel impelled to secrete milk. This impulse is provided by the hormones generated in the body. The development of the mammary gland itself is due to the influence of a hormone which is formed in the ovary during pregnancy.

There is another group of hormones, produced by the ovary. They are the estrogenic ones, those that are responsible for the estrus cycle. Lactation is initiated and maintained by a hormone called prolactin or galactin or lactogen. This hormone is produced in a portion of the pituitary gland. Thyroxine, the hormone secreted by the thyroid gland, increases milk secretion and is regarded as a normal hormone controlling the milk secretion. The adrenal glands secrete a hormone which is also of importance in milk secretion. These active bodies have not been studied in much detail.

It is understood that the ovarian hormone inhibits the formation of lactating hormones or the prolactines in the first pregnancy. Up to that time the hormone bodies strive to construct the mammary for the subsequent needs. After delivery sufficient pituitary bodies come into operation. Then these lactogenic hormones predominate over the inhibitory hormones. During lactation and by the very operation of milking itself, the lactogenic hormones are excited.

When pregnancy is imposed while lactating, the two antagonistic hormones again renew their struggle, the inhibitory ones getting the upper hand till they

cause the milk flow to disappear in order to prepare the animal body for bearing the strain of the coming lactation.

It has also to be observed that the stimulation to produce milk is a inherited quality. Cows of a high milking strain will continue to produce milk even at the expense of their own body tissues when the supply of nutrients in the ration is not sufficient for both maintenance and production of milk. The capacity to produce milk, therefore, depends upon the individual and on its heredity and on its ability to secrete the necessary lactogenic hormones. From this point of view, it has been suggested that the injection of purified lactogenic hormones into heifers, after they have come to lactation, will be able to indicate from its reaction the future capacity of the animal to lactate.

1074. Feeding and milk secretion : Mere feeding cannot help the production of milk. If the hereditary quality is wanting extra feed will go to make extra meat and fat for the cow, instead of increasing her milk ; and this extra accumulation of flesh and fat will react with disadvantage in bringing the cow to heat and tend to push her towards sterility. (971)

1075. Milking : For milking the cow her udder should be cleaned. If the body of the cow, her flanks and her tail are soiled, some dirt is sure to get into the milk pail and contaminate the milk. Dry cleaning would be the best thing to do. Rubbing with litter and straw will clean the body and the tail. The udder should be wiped with a clean piece of cloth. If one

wiping is not enough a fresh piece of cloth should be used to ensure that there is nothing about that can contaminate the milk.

The milker should have his nails pared and hand washed clean with soap before milking.

The milk pail should be thoroughly clean. The milk-men must see that milk from clean udders and teats is milked by clean hands into a clean milk pail. The time of milking should be regular. If the cows are milked twice, as they generally should be in the case of ordinary breeds, the milking should be done at equal intervals of 12 hours. If it is 4 A.M. in the morning it should be 4 P.M. in the afternoon. If there are three milkings the timing should be at 8 hours interval. In case of four milkings the interval should be 6 hours.

Milking should be done at a quiet, sheltered place and every day at the same place for the same cow. Begin milking with a kind word to the cow and end the milking with a kind word and patting. The cows love to be treated like that. Some give tasteful concentrates at the time of milking. This does not necessarily induce her to give more milk. But as an evidence of considerate treatment, it has a psychological value. If this is done it should be done every day, and not on occasions.

Strangers should not be about when a cow is being milked. When there are several cows and several milkmen, the same man should attend the same cow every day. Change of the milker is repugnant to the cow. A milker who properly and carefully

milks her is liked by her. The same milker should attend every day. Every change of milker induces disturbance, and less milk-flow is the result.

1076. Stripping and full-hand milking : The correct way of milking should be learnt from an experienced milker. The thumb should not be put inside the grip for pressing the teat while milking.

Two methods are practised in milking, the stripping and the full-hand milking. In stripping the teat is held between the thumb and the fore-finger and then the milk is brought out by pressing and drawing them down to the entire length of the teat. This causes the the flow of milk in a stream. Both the hands are used for milking two teats. The fingers are alternately stripped down, let go, and the teat is again gripped at the base. When the nearest pair is milked the remote



Fig. 50.

The art of milking—
stripping.

(Feeding and Milking of Cows)

pair is then begun. By quick alternation of the two hands, the stream of milk coming, though alternately from each teat, supplies in effect a continuous flow.



Fig. 51. The art of milking—full-hand milking.

(Feeding and Milking of Cows)

Full-hand milking can be used for animals having large teats which may be fully gripped by the clasp of the palm of the hand. It is not practicable in the case of small cows or cows having small teats. Large milkers and buffaloes have teats suitable for full-hand milking. In this, the teats are pressed or squeezed by the pressure of the grip of the palm and the fingers. Two teats are gripped alternately by each hand. This gives greater flow of milk as the hands are not moved up after every squeeze. Stripping produces frictional irritation. Full-hand milking resembles sucking to a

certain extent, and the cow feels easy when milked by this method. Full-hand drawing leaves some milk

in the udder which has to be milked down by stripping. Milking should be done fast enough, once it is commenced. Expert milkers do the job more quickly than others, and get more milk from the udders. The yield of milk depends to a degree upon the milker, a good milker getting more milk out of the same cow and that in the shortest possible time.

1077. Fat in strippings : The strippings or the milk drawn at the time of finishing the milking contains a much larger percentage of fat in it than in the beginning. The first streams of milk may contain as little fat as one per cent, and the last portion 8 or 10 per cent in a cow with 4 per cent average fat in the milk. There is a practice in towns of taking the cow from house to house and milking her at each customer's place. The first customers get milk which is very deficient in fat, while those who get the final strippings of milk get an exceedingly high content of fat.

After milking, the quantity obtained should be weighed and transferred to vessels either for storing or for transporting. In transporting bulked milk the milk-can should be a vessel, capable of being thoroughly cleaned out. The can should have a cover. Milk should be ladled out by a ladle which is also a measure. The ladle should be hung inside the can from a looped projection inside it. It then remains clean and rests in a safe place in the can at its side when not in use.

1078. Fat in morning and evening milk : Evening milk is richer in fat than morning milk. This fact

should be remembered when serving customers or when evaluating the fat-content of milk.

1079. The milk pail and machine milking : The pail should be preferably a vessel with a round bottom having no creases anywhere in its construction. Creases and corners prevent quick and sure cleaning. A round surface offers no place for lodgment of dirt. (1175)

Cleaning the milk-pail should be an object of attention. All dairy utensils are effectively cleaned, first by washing with cold water. In case of very greasy ones, wash them with hot water, then they are well rubbed with fine soft wood ashes ; again cleaned with water, scalded with hot water and kept in the sun for drying. If the atmosphere be very dusty the utensils are rinsed with clean water before use.

For sanitary milking as also for labour-saving purposes, milking machines have been introduced. There is no question of their employment in rural India. In town-dairies they have been proved to be of doubtful utility. The use of tubes is involved in the construction of milking machines. It is difficult to clean these tubes with the thoroughness which is necessary. Rubber tubes lodge a coat of milk inside, which can be entirely cleaned with difficulty. The use of steam is not possible as the life of the rubber is materially shortened by it. On account of these defects some of those dairies that imported milking machines are discontinuing their use.

After milking, the calves may be allowed for a short time to remain with their dams. By staying longer

than necessary, they tease the dams. This should be prevented.

1080. The virtues of milk :

The people who have achieved,
Who have become large, strong, vigorous people,
Who have reduced their mortality,
Who have the best trades in the world,
Who have an appreciation of art, literature and
music,
Who have progressed in science, and every activity
of the human intellect,
Are the people who have used liberal amounts of
milk and its products.

—Dr. E. V. McCollum.

—(Cited by Manian—"The Cattle Wealth of India").

Literature, ancient and modern, is full of the praise of milk as the perfect nutrient. The virtues claimed for it are many and various. Indeed, modern scientific literature on the subject is full of the many life-giving and life-sustaining qualities of milk, which cannot be sought for from any other single food.

Milk is still regarded as the mysterious fluid, containing about 101 different substances. No amount of skilful blending of the known constituents of milk can equal it. No other nutritious liquid could be like milk. It stands by itself unparalleled. Its total nutritive value is greater than the sum-total of the nutritive values of its component parts. Milk, therefore, is equal to its components, plus something more. There are 19 amino acids in its three

proteins mentioned already. It has 11 fatty acids in its butter fat, 6 vitamins, 8 enzymes, 25 minerals, 1 sugar, 5 phosphorus compounds, 14 nitrogenous substances, all suspended or dissolved in the fluid.

1081. The Vedic praise of milk : From the earliest days of civilisation in India the cow had been held in veneration, and milk had been extolled.

Dr. N. N. Godbole in his "Milk—The Most Perfect Food" cites passages from the Vedas, extolling milk. A chapter may be filled with quotations of the virtues of milk from writers, ancient and modern.

“वशाया दुग्धं पोत्वा साध्या वसवश्चये ।

ते वै ब्रह्मस्य विष्टपि पयो अस्या उपासते ॥

अथर्व वेद १० । १० । ३११

When these Sadhyas and Vasus have drunk the outpourings of the cow, they pay adoration to her milk in the Bright One's dwelling place."

“पयो धेनूनां रस ओषधीनां जवभर्वतां कवयो इन्वथ ।

अथर्व वेद ४ । २७ । ३

Bards who invigorate the milk of the milch-kine, the sap of growing plants, the speed of coursers."

“संसिंचामि गवां क्षीरं समान्येन बलं रसम् ।

अथर्व वेद २ । २६ । ४

I pour together milk of kine with butter, blending strength and juice."

1082. Milk—a perfect emulsion : As an emulsion, a suspension of oil matter in water, it is unequalled. No emulsion can equal milk in its perfection. Cow's milk in India contains 5 per cent or one-twentieth of its weight of fat. This fatty matter is broken into minutest globules and suspended in the medium. Such is the character of the suspension that the fat does not easily separate out on standing or even on boiling. There is a slow separation on keeping milk for a long time when fat tends to float up and form a creamy layer on the top. This process is hastened by shaking and churning or even by boiling and keeping. Advantage is taken of this character in separating cream and butter milk. Most emulsions separate on heating, but milk is an emulsion which is unrivalled in this respect. It does not separate on heating.

1083. The casein-content : The casein of the milk is another wonderful protein matter. It does not coagulate on heating. On concentration it is made insoluble, but by simple boiling its solubility remains.

The suspended fats and proteins give the requisite material for nourishment and for the formation of flesh and bone. Milk can be replaced by nothing else. It is significantly called a perfect food in as much as bone and flesh can be made out of it alone. It is a little deficient in iron but the mother puts in enough of the material in the child, before it is born, so that it can continue for six months without any other food. After that the deficiencies

of milk have got to be replaced. Naturally, it is meant to be the only sustenance for the young. But young and old, all equally get sustenance out of it.

1084. Man and cow association : (946) The wonderful discovery of the qualities of the cow, her milking capacity, her herbivorous habit by which she ingests crude fodder and voids valuable urine and dung to restore fertility to the soil, the working capacity of her male off-spring had made her indispensable to man. The Aryan civilisation would not have been what it is but for the cow and her milk. The mare also gives milk, and the horse also gives work, but not of the nature that the cow gives. The horse cannot thrive on the food on which the cow can. The horse cannot digest the large quantity of leafy material that the cow subsists on. The horse requires grains and concentrates. What a blessing for India and for her civilisation that the men of the hoary past took kindly to the cow, refused to slaughter her for meat but loved and developed her milking capacity and put her male progeny to work ! It was most superb and one of the grandest acts for civilising humanity. By loving the cow, men become more humane.

This milk, therefore, that we get out of the cow is associated with greater things than the immediate nutritional factors in it, incomparable, superb and unsurpassed though it be in nutritive value.

1085. Milk—its industrial uses : Men have put milk to a hundred uses. Casein has given the chemist

a wonderful material to manufacture an endless number of things with it and put it to uses which excite our wonder.

In the *Indian Farming*, in its monthly clip July, 1942, the following occurs under the heading '*The Milky Way*'.

"The barrels of most of our fountain pens, and Eversharp pencils are made from milk plastics. The gloss of fine writing paper is entirely dependent upon milk for its finish. Milk is used in the preparation of plywood for airplanes to help men fly....."

"... ..Prof. G. H. Rollings of Virginia Polytechnic Institute says :

'Soon you may be crawling out from between blankets made of milk, spread on a bed which milk holds together, in a milk-painted room. A rug of milk can protect your feet from the cold floor. You may turn on a faucet handle of milk to produce your morning shower, after which you may shave with a milk-handled razor. You may comb your hair with a comb of milk, and brush it with a milk-backed brush, and perhaps, admire the results in a milk-backed mirror.

'You may don your suit of warm milk-wool, held in place by buttons of milk and matched to the "T" with your milk plaid necktie. Probably you will wish to turn the milk knob on your radio and press the milk-button for the station you like to listen to. Your cream-drenched cereal may be served in a bowl of milk, and eaten with a milk-spoon. After

you have finished eating you can open the milk-wrapper of a cigarette package for your smoke. Before leaving for the office you should kiss your wife on the forehead, made soft by milk-base beauty culture. Last but not least, do not forget to take out your milk-barrelled fountain pen and write a cheque on another sheet of milk-surfaced paper to pay the bills.' (the milk bill)."

—(*From the Goat World.*)

This is the modern manufacturer's description of casein products. In India we do not want milk casein to be put into all these fascinating uses. A far more fascinating use would be to use the casein substance as human food to give some flesh and blood to our starving children. That would be the real 'white magic' or the real milky way.

1086. Milk consumption in various countries :

We have not enough milk necessary for the nutrition of our people. Indians had known better days, and India was a place flowing with "milk and honey" in the not very remote past. To-day everything has gone wrong. We have seen one way to put ourselves right by caring for the cow and by the preservation of its excreta for growing more food. The use of milk is with us for nutrition and not for making fancy products. India is the only country in the world which possesses the highest bovine population and has the least quantity of milk for her human population. The following Table gives the per capita consumption of milk in different countries and also in India.

TABLE—105

Estimated total production of milk and estimated production and consumption per head of twenty countries.

Country.	Total production of milk. (Million gallons.)	Human Population. (Thousands.)	Daily production per head of population. oz.	Daily consumption per head of population. oz.
New Zealand	870	1,559	244	56
Denmark	1,200	3,551	148	40
Finland	620	3,666	74	63
Sweden	980	6,233	69	61
Australia	1,049	6,630	69	45
Canada	1,580	10,377	66	35
Switzerland	607	4,066	65	49
Netherlands	970	7,935	54	35
Norway	290	2,814	45	43
U. S. A.	10,380	1,22,775	37	35
Czechoslovakia	1,200	14,730	36	36
Belgium	651	8,092	35	35
Austria	545	6,760	35	30
Germany	5,096	66,030	34	35
France	3,150	41,835	33	30
Poland	1,990	31,948	27	22
G. Britain	1,474	45,266	14	39
Italy	1,050	41,177	11	10
Roumania	382	19,033	9	9
India	6,400	3,52,838	8	7

—(*Report on the Development of the Cattle and Dairy Industries of India—Norman C. Wright*).

The *per capita* consumption of milk is shown to be only 7 ounces in India. Since the above figures about India were published there have been fresh estimates. After the Wright's Report was published some of the high milk-producing provinces passed through a fodder famine successively for 5 years, which reduced the cattle population of those milk-producing areas, resulting in a fall in milk production.

1087. Lessened milk production after 1937 :
"Report on the Marketing of Milk in India & Burma,"
(1941-42) has dealt with the position thus :

"These revised figures have brought to light the important fact that the *per capita* consumption (in 1941) has dwindled down further by about 12 per cent to 5·8 oz. per day as compared with the estimate of 6·6 oz., based on 1931 human census and 1935 cattle census.....The reason is that in areas noted for milch cattle, e. g. Sind, Rajputana, Kathiawar and South Eastern Punjab, there were famines during 1935-40, and the total number of milch-cattle decreased appreciably...."

Against the estimated out-put of 6,400 million gallons, the Marketing Report estimate was 7,446·9 lakh maunds or 5,957 million gallons. The difference is not very great, specially in view of the wide guess-work and generalisations that have to be made. The real *per capita* decrease is due to the increase in population, according to the 1941 census.

When the land has recovered from the effects of famine, the figures may again come back to the old place. Still this 6·6 or 7 oz. milk per head is too

miserable a thing for the country to be contemplated without being perturbed.

1088. **Milk production may be increased by 60 per cent :** For want of milk the nutritional problem has taken an acute shape. Disease is taking its quota in increasing numbers. Diseases connected with mal-nutrition and poverty are continually on the increase. Despite the expansion of the drug market and the consequent extended use of drugs, despite the increase in the number of medical men, the death-rate has been increasing. An increased birth-rate may be more than counter-balance the death-rate, yet the position remains that a nutrition famine is stalking through the land, the evidence of which lies in low milk production and consumption. The Marketing Report says that milk production can be at once raised by 60 per cent by better feeding and care without any improvement of the breed. I believe that much better than that can be done by judicious and adequate feeding, and that double the quantity of milk may be produced, provided the obstacles are removed. These obstacles are not the religious prejudice of the people, but the inability of the people under the present political circumstances to do what they should do for the cow. The means for removing the obstacles have been described in **Part II.** on how to save the cow. And if the cow can be saved, men and women, of course, will be saved. Saving of the cow means saving of human beings in India.

We cannot be satisfied with increasing the production of milk from 6 or 7 ounces to 12 or 14 ounces

per head, and we must bring the consumption of milk up to 40 ounces per head per day which is 6 times the present production and consumption. And this even is not an impossible task.

In comparing Indian consumption with the figures of other countries, the Report of the Marketing Committee pointed out that American or European cow's milk contains 3·8 per cent of fat, while the milk of the Indian cow contains 5 per cent fat and that of the buffalo is yet more, or 7 per cent. The two together will give on an average 6 per cent fat. Evaluating milk on its fat-content only and bringing Indian milk to a fat-content of 3·8 per cent from the average of 6 per cent the Indian consumption of 5·8 ounces increases to 9·2 ounces *per capita* per day. But this method of calculation will neither place India on a higher level of estimation as a consumer of milk nor will the health of our people show any improvement. Fat is not the only assessable nutritive constituent of milk. The non-fat portion of milk is no less important from the nutritional point of view. This much only can be said that on the basis of the European standard of milk, Indian milk is superior.

1089. Milk in rural and urban areas : It has been mentioned that the total milk production in India was estimated at 6,400 million gallons by Wright, and the latest estimate (1941-42) in the Marketing Report places the gross production at 7,446·9 lakh maunds which at 8 gallons to the maund comes approximately to 5,957 million gallons.

It would be wrong to suppose that all this milk is from the cow. Of late, buffalo milk has been seriously increasing. Men in the milk trade have been pushing the cow down and favouring the buffalo which has been put forward as a competitor to the cow, but whose milk is sold in the name of the cow. Because the producers of buffalo milk get this undue advantage, and because of some other circumstances mentioned already, the cow has been losing ground. The total milk out-put of India is shown below as derived from cows, buffaloes and goats.

1090. Comparative milk out-put—cow, buffalo and goat: The number of each animal, their respective milk-yields and their percentage to the total production is given in the following Table.

TABLE—106

Summary of milk production in India.

Description.	Cows.	She- buffaloes.	Goats.	Total.
Milking animals (lakhs) ...	490	214	98	802
Percentage to the total animals ...	61	26·8	12·2	(100)
Annual yield of hand-drawn milk per animal (pounds)	486·7	1,229·2	161·8	—
Annual net production of milk (lakh maunds) ...	2,897·9	3,202·8	192·2	6,292·9
Percentage to the total production ...	46·0	50·9	3·1	(100)
Quantity of milk consumed by calves and lambs (lakh maunds) ...	763	332	59	1,154
Annual gross production of milk (lakh maunds) ...	3,660·9	3,534·8	251·2	7,446·9

—(Marketing Report, 1941-42.)

It will be seen that although the numerical relation between the cow and the buffalo is 61 to 26·8, yet the production of milk is nearly equal—being 3,660 lakh maunds for the cow against 3,534 lakh maunds of the buffalo. Very roughly one buffalo gives milk equal to 2·35 cows.

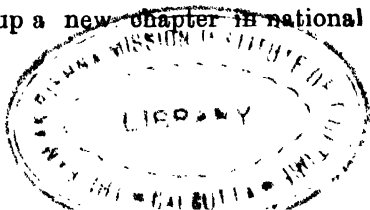
“...village cows when brought to the Government Farms give on an average 60 per cent more milk in their subsequent lactations. The first progeny of these cows show a further improvement of 10 to 15 per cent in their milk yields over and above the increase recorded by their dams.”

—(*Marketing Report 1941-42*. P.—19).

This means a 60 per cent increase in the milk-yield of the cow in the first generation. The buffalo shows no such progressively greater milk-yield ; and the first increase is only 20 to 25 per cent.

The first calf may be lactating on the 3rd year, so that in 3 or 4 years the milk-yield from the cow alone may go up by 2,500 lakh maunds and the value at nearly 104 crores of rupees.

In other words, if the 500 lakhs of cows can be well fed, the increase in national wealth in the first year will be 89 crores of rupees and in the fourth year 104 crores. This will leave a very large margin over their extra-feeding costs. Cows are not even given the bare maintenance ration for their continued existence. This opens up a new chapter in national economy. (127)



1091. Milk-yield per animal in provinces :

TABLE—107

Showing the milch cows and buffaloes in the various states and provinces, their milk-yields and the percentage they bear to the milk production of buffaloes.
(Report of the Marketing of Milk, 1942)

	Cows.				Buffaloes.			
	3 years old kept for breeding or milk prod. lakhs.	Approx. annual yield per cow. lbs.	Annual production of milk in lakh maunds.	Per-centage to total cow milk.	3 years old kept for breeding or milk prod. lakhs.	Approx. annual yield per she-buffalo. maunds.	Annual production of milk in lakh maunds.	Per-centage to total buffalo milk.
Kashmere State	7.8	280	24.9	0.86	3.6	570	24.9	0.78
N.W.F. Province	2.1	1,200	30.6	1.06	1.6	1,620	31.9	1.00
Do. Agencies and tribal areas	1.6	780	14.6	0.50	1.3	900	14.0	0.44
Br. Baluchistan	0.6	1,000	7.7	0.27	0.04	900	0.4	0.01
Baluchistan States.	0.7	1,300	11.0	0.38	0.01	1,800	0.3	0.01

ab	...	22.3	1,445	391.9	13.53	28.9	2,820	814.9	25.45
Rajputana	...	38.2	730	339.2	11.71	19.13	900	209.3	6.53
C. I. States	...	16.6	730	147.3	5.03	6.8	1,000	76.6	2.89
Sind	...	7.1	1,315	113.8	3.90	3.3	2,320	105.8	3.30
W. I. States	...	4.3	1,000	52.3	1.81	3.9	2,500	118.1	3.69
Gujarat Agency	...	1.9	600	18.9	0.48	1.1	1,000	13.7	0.43
Baroda State	...	1.6	345	6.8	0.23	3.6	1,810	79.2	2.47
Bombay Province	...	19.7	140	38.6	1.16	13.0	840	133.0	4.15
Mysore State	...	14.4	240	42.1	1.45	5.4	590	98.7	1.21
Madras Province	...	50.0	450	273.4	9.44	28.7	800	279.0	8.71
Central Provinces	...	34.6	65	27.8	0.94	8.9	545	58.8	1.84
Hyderabad State	...	26.0	130	41.1	1.42	13.0	825	130.4	4.07
U. P. (1935)	...	57.3	625	435.8	15.02	40.6	1,240	611.9	19.11
Bihar	...	28.8	620	216.1	7.47	11.0	1,650	220.6	6.89
Orissa	...	14.8	850	68	2.17	1.4	750	12.8	0.40
Bengal	...	74.8	420	381.6	13.17	2.0	900	23.4	0.78
Assam	...	17.2	140	29.2	1.00	1.6	315	6.3	0.20
...	...	—	—	—	—	—	—	—	—
...	...	—	—	—	—	—	—	—	—
All-India Total	...	489.9	486.7	2,897.9	(100)	214.86	1,229.2	3,202.8	(100)

An analysis of the figures for cow milk will show that several provinces enjoy a special place in milk production. The approximate yield per cow per annum is the highest in the Punjab, being 1,445 lbs. ; Sind closely follows with 1,315 lbs ; then come the Baluchistan States, with 1,300 ; next in order is the N. W. F. P. with 1,200, and the W. I. States with 1,000 lbs. per cow. One would have ordinarily expected that Madras with her Ongole breed would take a place of eminence. But the fact is that Ongole is a small area in the whole Presidency, and the latter as a whole is not much different with regard to milk-yield per cow of 450 lbs. from the 420 lbs. of Bengal. Bihar and the U. P. have a slightly superior position with their 620 and 625 lbs ; Orissa (350) and Assam (140) range below Bengal, while Bombay ranges with poor Assam, having 140 lbs. only. The Table is a revealing one, and shows that the rice-area cows of Bengal, Assam, Orissa and Madras can quickly rise to the next higher grade of Bihar and the U. P.

The poor yield of milk of the cows in the provinces of Madras (450 lbs.), Bombay (140 lbs.) and C. P. (65 lbs.) per year per cow should be studied in another light. The enumeration of the cows includes all the cows above 3 years that are kept for breeding. In the better breeding areas of Madras, Mysore, Bombay and the C. P., the rearing up of male calves for making efficient bullocks is so much looked for that the milking of cows is not intentionally done for fear of stunting the growth of their male calves. It has

been mentioned that the better breeders of the Kangayam breed take recourse to engaging foster mothers for feeding milk to their male calves which receive extra milk in addition to all that they receive from the full out-put of their dams.

In the C.P., near about Wardha and Nagpur, or, say, in the cotton-area in general, better bullocks are highly prized and, therefore, the milking of cows is not given any importance. The villagers simply do not consume milk products. The demand for milk in the trade centres and marts is met largely from the town *gowalas* who keep she-buffaloes for milking in these localities.

The figures are thought-provoking, and those interested in the welfare of the cow will find avenues for work in the various provinces in the light of this Table. The respective population of cow and buffalo will reveal where danger is threatening the cow.

1092. Milk in rural areas and cities : Milk is being drawn away to the city, leaving to the villagers yet less milk for home consumption. This is an unhealthy symptom. The bulk of the people of India live in the villages. The improvement of their health is primarily a question of the improvement of the health of villagers. The hunger for money and the fascination for it are driving the villagers to send more and more of this life-giving article to the towns in the form of liquid milk and in the form of milk products, the chief amongst which is *ghee*.

TABLE-108

*Daily per capita consumption of milk in cities
in ounces (1935).*

	Fluid milk.	Dairy products in terms of milk.	Total consump- tion.	Corres- ponding Provincial consump- tion.	Ratio of Urban to Provincial consump- tion.
Peshawar	4.5	11.9	16.4	6.8	2.4
Lahore	4.0	12.4	16.4	15.2	1.1
Delhi	4.9	17.8	22.7	5.2	4.4
Karachi	6.1	11.9	18.0	18.0	1.1
Hyderabad	5.8	14.1	19.9		
Sukkur	4.0	10.1	14.1		
Sikarpur	8.8	16.0	24.8		
Lucknow	3.4	14.0	17.4		
Cawnpore	3.3	12.5	15.8	7.0	2.5
Agra	3.0	15.8	18.8		
Patna	3.8	5.0	8.8		
Cuttack	0.6	2.9	3.5	3.4	1.0
Calcutta	3.8	6.0	9.8	2.8	3.2
Dacca	3.0	5.0	8.0		
Shillong	2.1	5.8	7.9	1.3	6.1
Bombay	4.3	11.3	15.6	5.5	2.7
Poona	4.2	9.8	14.0		
Nagpur	2.2	3.9	6.1		
Hyderabad (Deccan)	2.5	.7	7.2	3.9	1.9
Bangalore					
City	2.5	3.6	6.1	4.4	1.4
Madras	2.3	4.6	6.9	3.7	2.0
Madura	2.9	5.3	8.2		
Trichinopoly	2.6	4.5	7.1		
Average of 23 cities	3.7	8.9	12.6	5.8	2.2

—(Report on the Marketing of Milk, 1941-42.—P. 58).

1093. Details of milk consumption : That the cities and towns consume a disproportionately higher rate of milk is clear from the above Table. The last column shows that on the average of 23 cities, the urban population consume per head 2.2 times the quantity of milk consumed by the rural population. The matter is elaborated from another direction also in the Marketing Report.

“Figures of fluid consumption in 50 towns and cities in different parts of the country show that on an average one maund of milk per head per annum is consumed by the urban population. On this basis the entire urban population comprising 374 lakh persons consume annually an equal number of maunds of milk. In addition, 426 lakh maunds are made into products e.g., curd, ice-cream, *rabri*, *malai* etc. in urban areas and about 50 lakh maunds are used in preparing cream and creamery butter. In all, therefore, 850 lakh maunds of milk or approximately 14 per cent of total milk production in India enters the fluid milk trade of the country.”

The fluid milk trade mentioned above is for the consumption of the 374 lakh persons residing in our towns and cities. Of the population the richer people take the largest share and the poorer people get less than the all-India figure.

1094. Conversion of milk into milk products
The towns, besides consuming 14 per cent of the total milk as fluid, consume the largest portion of the *ghee*. The distribution of total milk production into *ghee* and other products are as under :

TABLE—109

Usages of milk in India.

	Annual quantity. (lakh mds.)	Percen- tage to total pro- duction.	Percentage to total quan- tity converted into products.
Consumed as fluid	1,762·18	28·0	...
Converted into <i>ghee</i>	3,589·14	57·0	79·2
„ <i>Khoa</i>	311·67	5·0	6·9
„ Curd	327·95	5·2	7·2
„ Butter	101·56	1·7	2·4
„ Ice-cream	21·35	0·3	0·5
„ Cream	23·62	0·4	0·5
Other products	149·44	2·4	3·3
Total—	6,292·91	(100)	(100)

1095. Towns consume over 40 per cent : It will appear that 57 per cent of the total production of milk go to make *ghee*. The major portion of it enters the towns. The towns, therefore, consume in addition to the 14 per cent of the total milk a good portion of the 57 per cent used for the making of *ghee*. Taking *ghee* to form half the nutritional value of milk of the 57 per cent, half only remains in the villages in the form of *lassi*, and nourishes the producers and their neighbours. Of the other half, say 28 per cent, the major portion in the form of *ghee* leaves the villages and may be guessed to be, say, 16 per cent. This 16 per cent with 14 per cent of fluid milk constitutes 30 per cent of the total milk production. Considering the importation into towns of *Khoa* and other milk products it may be guessed that 40 per cent or more

of the total production enters the towns. As for liquid milk-consumption 28 per cent is its share out of the total milk-production.

The Report says that of the entire fluid milk consumption in the country, half or 14 per cent is consumed by the townspeople. It is an enormous draw, this 40 per cent of the total milk production, and attempts should be made to stop this draw on the health of the villages. But the modern trend is in favour of finding more market for milk and milk products in the towns. The Milk Marketing organisation, set up by the Government, has one definition of the scope of its action—it is the marketing of milk and milk products for towns. A perusal of the entire Report leaves this impression in the mind of the reader. Schemes for better facilities for transporting milk to the towns are put forward in abundance.

If the towns want more milk, let more be produced near them, and let no temptations be spread for collecting the quantities from larger areas round the cities, impoverishing the health of the rural people. An observer may find that the people in the neighbourhood of the towns, despite their greater income are more sickly, poorer in health and more subject to diseases, than people living in places which are more distant from the towns. The reason for this deterioration is that all the nutritive materials from their localities in the neighbourhood of the towns: milk, fish and vegetables find their way to the towns through wholesale purchasers who have no concern for the

health of the local people. The Milk Marketing Report is full of suggestions for the exploitation of even distant villages for feeding the towns with milk.

1096. Milk for villages : A commodity like milk produced in the villages, should remain in the villages. The needs for the townspeople should be supplied by greater production of milk in areas near about them, where fodder for the town milk supply should be specially grown. Keeping large herds of cattle about the towns will serve to famish the cattle of the neighbourhood by a draw upon the limited fodder supply of the villages. If the villages are to be saved from the hunger of the towns, the townspeople will have to make arrangements for keeping cows for the town milk supply and also make arrangements for growing fodder for them.

1097. Cost of milk production : The Indian Council of Agricultural Research worked out in 1932 the cost of milk production in Government Farms and Dairies. After that the following set of figures are the only reliable ones up to date.

TABLE—110

Cost of milk and ghee production on Govt. Farms & the price obtained by village producers in the Punjab.

		Per seer					
		Cost at Govt.			Rural producer		
		farms.			sale price.		
		Rs.	A.	P.	Rs.	A.	P.
Cow milk	...	0	1	6	0	1	3
Buffalo milk	...	0	1	10	0	1	5
Buffalo ghee	...	1	10	6	1	0	6

—(Marketing Report, 1941-42.—P. 114)

It will be seen from the Table given in Para 122 and the above that the cost of milk at the Government farm for Sindhi and ordinary Sahiwal cows is 9·42 pies and 9·18 pies per pound respectively which is near about $1\frac{1}{2}$ annas per seer. This cost is the cost at the Government Farms which are most efficiently managed under expert supervision, housed in excellent premises, with pasture and every facilities. Here the cost is $1\frac{1}{2}$ anna per seer without taking the expensive supervision charge into account.

1098. Milk cost of farm and village animals :
The Government farm animals enjoy immunity from the fatal contagious diseases by being suitably protected by vaccination and inoculation etc. Healthy and fit cows in tip-top condition are kept while poor yielders are discarded in these farms.

Here even, the better the cow or the herd, the lower the cost as the comparative figures in the Table Para 122 for ordinary Sahiwals and Ferozepur Sahiwals of 9·18 and 7·16 pies respectively would show. But the ordinary Sahiwals at Government farms are extraordinary animals compared with the villagers' Sahiwals. The yield of the ordinary Sahiwal at Government farms has been shown as 3,800 lbs. per lactation. It is found from the Village Enquiry Report of the Seven Tracts that in the Montgomery tract (the place of the Sahiwals) the yield of a cow per lactation is 1,343 lbs. Milk from cows producing 1,343 lbs. per lactation must cost much more than that from the same breed of cows producing 3,800 lbs. in Government farms.

1099. The villagers sell at a loss : The village cows of the same breed produced a little over one-third of the production in the Government Farms. The cost in villages for milk from such cows should be at least double that in the Government farms i. e. 3 annas per seer in place of $1\frac{1}{2}$ annas per seer. This observation is applicable to one of the best milk-yielders in India. With the poorer quality of cows, with the average cows of Madras, Orissa, Bengal, Bihar, producing about 400 to 500 lbs. of the all-India average per lactation, the cost of production may be imagined. When such milk is encouraged to be exported to towns from a distance of a 50 or 100 miles radius, it means depriving the villagers of one of their most-prized articles of nutrition at an unfair price, much below the cost of production, simply by the temptation of providing them with cash. A man in distress may sell a property at one-fourth its price. That price is not a fair price, and no Government can scheme for enlarged transaction on that basis.

In the matter of *ghee* the cost shows Re. 1/10/- per seer at Government Farms against Re. 1/- per seer, the sale price of the rural producers. Here the difference is still greater. In discussing the price position the Report of the Marketing Committee observed :

“Higher initial cost of cattle and the greater depreciation of their value, higher cost of feed, heavier feeding, greater labour charges etc. on Government Farms are likely to raise the cost of

production compared with that incurred by the villagers. But the greater efficiency of the farm cattle at the pail may outweigh all these factors and produce cheaper milk than the village cattle."

If this argument is accepted then the village producers in the Punjab are obviously not getting the full return, and have to sell milk even for fluid consumption below its cost price.

From these facts it would appear that instead of attempting to procure cheap milk by collection from increasingly wider circles round the towns, it would be wiser for the Municipalities to arrange for production of raw milk for town-supply and also to grow the necessary fodder.

1100. **Milk price should be raised :** The problem is not how to get cheaper milk but how to feed the millions of half-starved cows. If the problem is solved, milk price will adjust itself to the changing condition, and people will enjoy all-round prosperity and better health. If the people become a little less poor, the price of milk will automatically rise to a fair level, for, people will not like to part with this health-giving fluid at prices which are uneconomic, and render them all the more incapable of spending on the feeding of their cows. On the contrary, if milk prices rise, the producers may better the condition of their cows.

1101. **The components of milk fat and solids :** The composition of milk varies with the breed of the cow, the period of lactation and the age of the

cow. In averaging a large number of samples, other factors of variation get somewhat corrected, and the outstanding difference due to the breed can be traced out. The following Table gives the composition of the milk of various breeds of cows.

TABLE—111

*Composition of milk of different breeds of cows.
(Adapted from the Marketing Report.)*

Breed.	No. of samples examined.	Specific gravity.	Fat Per cent.	Solids- not-fat, Per cent.	Authority and year of tests.
Amrit Mahal	58	1·027	4·58	—	S. Rao. Bangalore, 1918.
Ongole	48	—	5·05	—	Imp. Dairy Inst. Bangalore, 1927.
Sahiwal	134	1·082	4·65	9·20	Military Dairy Peshawar, 1916.
Sindhi	2,500	—	4·65	8·69	Imp. Dairy Inst. Bangalore, 1940.
Gir	780	—	4·54	9·15	Do.
Tharparkar	50	1·081	4·60	9·63	} Imp. Cattle- Breeding Farm, Karnal, 1934.
Haryana	40	1·081	4·60	9·68	

The above Table shows the analysis of over 3,500 samples of milk from various breeds. It will be found that no sample shows less than 4·5 per cent fat. We may take that 4·5 per cent is the minimum fat-content of the milk of Indian cows. Individual samples may show less fat under special circumstances, such as milk from a newly-calved cow or the milk drawn at the first stage of milking. But when milk is bulked, and the milk of different cows in a herd is mixed together, then these aberrations

correct themselves and the result comes up to the average of over 4·5. Therefore, 4·5 per cent fat is to be taken as the minimum level of cow milk in India.

1102. **Night and morning milk :** It has been mentioned that the evening milk contains more fat than morning milk. This, however, should not be taken as an absolute standard. The following Table gives the fat-content of milk from cows milked at different hours. The cows are of European breed, and the place of experiment is not India. The fat percentages are, therefore, not applicable to the milk of Indian cows which show 1 to 1½ per cent more fat over European breeds of cows. The Table only shows the variations of fat at different times of milking.

TABLE—112

Three times a day milking—effect of length of interval.

After interval,	Fat Per cent.	Yield lbs.	Weight of butter fat per milking. lbs.
Night : 12·5 hours.	2·59	119·5	3·10
Morning : 5·5 „	4·79	83·5	3·94
Afternoon : 5 „	4·88	63·0	3·08

—(*The Chemistry of Milk.*—*Davies, 1939. P. 26*)

It will be seen from the Table how night milk is larger in quantity but poorer in fat. It will also be seen that though the out-put of milk at the three different milkings are different, the total butter-fat in 5 hours of morning or evening milking is nearly

equal to the butter-fat in the milk collected after 12 hours interval at night. Davies opined :

“...Night itself or factors operating at night, tend to high production of milk of low fat-content. More weight of milk and fat are produced *per hour* during nine-twelve and fifteen hour night intervals than during the intervals of the same length during the day, the milk-increment being greater than the fat-increment. Milking at mid-day and mid-night, more milk and fat are produced *per hour* from mid-night to mid-day than in the other 12-hour interval, and in this case the fat increment is greater.”—(P. 27)

It has been mentioned that fat-content varies with the progress of milking at the same milking, the earlier collection being poorer and the strippings higher in fat. The difference is shown in the following Table.

TABLE—113

*Variation of fat-content of milk, during milking
(percentages of fat) Van Styke's results.*

Portion.	Cow A.	Cow B.	Cow C.
First	0·90	1·60	1·60
Second	2·60	3·20	3·25
Third	5·35	4·10	5·00
Strippings	9·80	8·10	8·30

“The maximum amount of fat will be given by quickness, combined with thoroughness of milking....”

—(*The Chemistry of Milk.*—Davies, 1939. P. 27)

1103. Fat-content and age of the cow : Davies quoted data from Spier who had collected them from observations for six months of 903 Ayrshire cows at approximately equal periods of lactation. The Table shows that the yield of fat is high when the cow is two or three years of age, and begins with 3·83 per cent. After that, the fat-content goes on diminishing slightly but steadily as age advances. The fat of the cow at 13 years of age is 3·42 per cent. These figures are, it should be remembered, from European cows. The fat percentages of Indian cows is expected to show similar gradation with age.

1104. Fatty acids in milk : The following fatty acids are found in major amounts in milk : Butyric, Caporic, Capryllic, Capric, Lauric, Myristic, Palmitic, Stearic, Oleic.

Besides these, there are traces of some unsaturated acids. Fat is a combination of the fatty acids with glycerine. It is technically a glyceride of fatty acids. When fat is broken up, the two components, glycerine and the fatty acids, are formed. This happens when the fat is treated with an alkali, as in soap making. The alkali drives out the glycerine portion and combines with the fatty acid portion, making the alkaline salt of fatty acid, which is, in fact, soap. Soap may again be broken up by mineral acids. On such break-up the pure fatty acids separate out. In order, therefore, to make acid out of fats, the first step is to make soap with the fat and then break up the soap with an acid.

The fatty acids of milk fat have been very closely studied, and from it a determination of the character of the milk-fat has been made. Some of the fatty acids of milk-fat are volatile in steam i.e., when distilled with water these acids pass out with steam and can be collected. Upon this behaviour of butter is based a test called Reichert Meissl test of butter-fat. Genuine butter-fat from cow-milk has to conform to a certain range of R. Meissl values. Similarly, fat from buffalo-milk conforms to another range of R. M. values, and in this way the fats from the two varieties of the cow and the buffalo can be differentiated to an extent. Milk contains some fat-soluble vitamins. When butter-fat is separated from milk, or when *ghee* is made from that butter-fat, these fat-soluble vitamins are carried over to the butter and *ghee*. More about them is discussed when dealing with *ghee* in Chapter 25 and following.

1105. Fat and non-fat contents of milk: Other solid contents of milk are casein, milk sugar and mineral salts. Vitamins stand by themselves as milk constituents. The solid substances together are classed as solid-not-fat or in abbreviated form it is expressed as S. N. F. or s. n. f. The solid-not-fat of milk varies with the character of the milk, but not so widely as the fat-content.

1106. Fat affects specific gravity of milk: The fat-content and solid-not-fat-content of milk together go to characterise the specific gravity of milk. Specific gravity is the weight of a volume of a fluid as compared with the weight of the same volume

of water taken as the unit. The specific gravity of water is the unit or 1. For convenience this unit is expressed as 1,000. The specific gravity of milk is about 1,028. The two factors contributing to the specific gravity, fat and solids-not-fat, operate in opposing ways to influence the specific gravity. Fat tends to diminish the specific gravity. Fat is lighter than water and, therefore, the more fat there is in the milk the lower will be its specific gravity. On the other hand, solids, sugar and casein and albuminoid contents and mineral salts tend to increase the specific gravity of milk. These opposing qualities of the milk-contents are taken advantage of by the unscrupulous dealers in adulterating milk, and yet keeping its specific gravity constant. The operation is very simple. Some fat is taken out. This taking away of a light substance has the effect of increasing the specific gravity. If milk was of 1,028 specific gravity to start with, after the skimming of some fat off the milk, it becomes heavier and the specific gravity rises, say, to 1,030. In order to bring down the specific gravity to its original level of 1,028, all that need be done is to add some water. This will lower its specific gravity.

This adulterated milk may now be further diluted with water, which brings down the specific gravity to say, 1,020. Thus if a milk on analysis shows low fat-content, say, only 2 per cent of fat, and a low specific gravity, say, 1,020, the interpretation would be that the milk has not only been robbed of half its fat, which would have left it with higher specific gravity,

but it has been diluted with so much water that it has gone down to 1,020. Such milk probably is adulterated with sixty per cent water. Mere addition of water without extraction of fat will also tend towards giving the same analytical results, namely, low fat-content and low specific gravity.

Specific gravity may be determined by a glass-instrument called lactometer. Lactometers indicate specific gravity at particular temperature. The instruments are graduated at 15 degree centigrade temperature. Unless milk is cooled down to that temperature the reading will not be correct. But, for comparing genuine and watered milk at the same temperature, these instruments may give some guidance. But, as has been observed before, it is easy to evade the lactometer test by properly doctoring the adulterated milk. For example, low specific gravity may be brought up higher by the addition of sugar to the watered milk.

1107. Solids-not-fat-contents of milk : The average content of solid-not-fat in the milk of the Indian cow is 8·9 per cent, while 8·5 per cent may be regarded as the minimum content. Of the solids-not-fat-content of milk, casein is an important item. It is a protein, associated with which are two nitrogenous substances—lactalbumin and lactglobulin. Casein is present in varying quantities from 2·2 to 3·5 per cent in the milk, the average percentage being 2·86; it is a phospho-protein meaning that phosphoric acid radical enters into its chemical composition. The other two proteins of milk,

lactalbumin and lactglobulin, together constitute 0·56 per cent. Of the two, the quantity of lactalbumin is twice that of lactglobulin.

Next to casein comes the sugar-content of milk or lactose. Milk has 4·8 per cent of lactose in it. The mineral-contents are expressed as ash, the substance that remains on drying and igniting milk. There is, on the average, ·72 per cent ash in cow-milk.

The total components of milk in view of the above results come up as under :

Indian Cow milk : Composition average per cent.

Fat	...	...	4·8 per cent.
Solids-not-fat	...	...	8·9 „
Casein	2·86	}	3·42
Lactalbumin	0·38		
Lactglobulin	0·18		
Lactose.	...	4·8	
Ash	...	0·72	
			8·94
Total solids.	...	...	13·7 per cent.

1108. Casein : Casein is a pure white, ashless, odourless non-crystalline solid. It is usually prepared as a fine crystalline powder. It is very hygroscopic or hungry for moisture when absolutely dry, but remains in equilibrium when there is 8 per cent moisture. More than 8 per cent moisture interferes with the keeping quality of the casein.

SOLUBILITY OF CASEIN : Casein is soluble in acids and alkalies. In a moist state it is totally soluble in very dilute solution of mineral acids such

as sulphuric and hydrochloric, and also in organic acids, such as citric or lactic acids. It dissolves readily in alkalies such as carbonates and bicarbonates of sodium and in borax.

Casein is precipitated from milk by disturbing the acid-alkali character of milk by the addition of dilute acid to the milk. It is precipitated by the action of rennin on casein solution or on milk. Casein, precipitated by the action of rennin, is called para-casein. It contains a number of amino acids, namely glycine, alanine valine, leucine, isoleucine, phenylalanine, tyrosine, serine, cystine, proline, oxyproline, aspartic acid, glutamic acid, tryptophane arginin, lysin and histidine. It is present in milk as a colloidal complex with acid calcium phosphate,

The character of *phospho-proteins of milk*, casein is similar to the phospho-protein of hen's egg—vitellin. From vitellin or the egg protein the entire developmental material of the chick within the shell is supplied. Milk-casein is very nearly of the same composition, explaining the effectiveness of the unique growth-promoting capacity of milk.

Protein gets clotted in the stomach by the enzymes. This clotting is of special value in case of the new-born. The clotted material gives volume and encourages muscular activity. On the other hand, fat globules are encased in the protein mass and allow small quantities in a fine state of division to go into solution by digestion. Lactalbumin and lactoglobulin are the other ingredients of milk. They are also perfect proteins but they are superior to casein because of the

fact that the sulphur-containing amino acid, cystine, is low in casein. The other two proteins make up for this deficiency. Lactglobulin, as has been mentioned, is a protein identical with serum globulin and is present in milk to the extent of half the quantity of lactalbumin.

1109. Milk sugar or lactose: Lactose is a disaccharide which can be broken up into two sugars, glucose and galactose. When the nitrogenous portion of milk coagulates out and is separated, all the fat of the milk gets embedded in the proteins and gets precipitated. The liquid that remains contains some mineral salts, and practically all the milk sugar or lactose. It is a crystalline substance in its pure state. When whey is concentrated by evaporation, crystals of lactose form. In the preparation of condensed milk, all the milk sugar remains in the viscous mass and the presence of large crystals of lactose may make the condensed milk gritty. Lactose is easily fermentable and when the whey from the manufacture of cheese or *chhana* is left out for sometime, fermentation sets in. Such whey is evaporated from vacuum pans or multiple-effect evaporators. The liquid is brought down to a concentration, containing 55 to 60 per cent total solids. This contains about 40 per cent of lactose. On cooling, large crystals separate out in a few days which are centrifuged and collected, yielding 3·5 to 4 per cent of the whey. These crude crystals are dissolved in hot water, de-colourised and re-crystallized, dried and ground to produce the milk sugar or sugar of milk of commerce.

It is used for making infant foods, and also in confectionary and for the sugar coating of medicinal tablets etc.

Some investigators give 95 as the digestibility value and 90 as the biological value of proteins of raw milk when fed at a nitrogen level of 8 per cent of the diet. Milk proteins act as supplementary proteins to cereal proteins. Here lies the importance of including milk in human dietary.

1110. **Mineral components of milk:** Cow-milk contains iron, and it is this iron that builds up the hæmoglobin of the blood. It is known that the iron-content of milk is not sufficient to meet the needs of the growing baby or calf. In cow milk colostrum has a much higher content of iron. It is 4 parts per million. According to Davies, cow milk ordinarily contains 1·5 to 2·4 parts of iron per million. Other investigators give different figures.

Milk contains a large amount of minerals necessary for tissue-formation. The rate of growth during early infancy is rapid and in this early period milk is the only source of inorganic or mineral constituents of the body. Milk has a good portion of calcium. Green vegetable matter, specially of leguminous plants, contains plenty of calcium, and all other foods are relatively poor in calcium. Milk supplies calcium in a more assimilable form than vegetables. In the diets of adults, milk is advocated to supplement the cheap carbohydrates which constitute the main food, as an additional and superior source of calcium. Calcium, phosphorus and vitamin D go

towards bone-formation and prevention of rickets in children.

Iron and copper are necessary to ward off anæmia, and milk supplies them. But this supply should be supplemented. Addition of copper causes rapid recovery from anæmia and creates a higher level of hæmoglobin.

1111. Copper-content of milk : The copper-content of milk contains about 0·3 parts per million of copper. Even this small quantity has far-reaching effects in the nutritional value of milk, as it helps the utilisation of iron in the system, and acts as a disturbing factor in the preservation of milk and milk products, causing auto-oxidation. Manganese, zinc, iodine etc. are present in traces in the milk.

1112. Properties of milk : In mammals, when the off-spring is delivered out of the uterus and it begins to have a separate existence outside, it is the mother's milk that keeps a connection between the mother and the off-spring. In the uterus, mother's blood was feeding it and contributing to its growth. Outside, as a separate being, so long as the off-spring is not able to pick up and digest food for itself, mother's milk provides the entire sustenance and also contributes towards its growth.

The growth-promoting property of even small quantities of milk, added to synthetic diets, drew the attention of the investigators to the various properties of milk, and vitamins were discovered during that search. After that many other interesting problems

on nutrition were undertaken for solution and were mostly solved.

The first supply from the udders, after parturition, is not milk but colostrum. Colostrum contains a much higher percentage of protein, the chief protein being lactoglobulin.

The lactoglobulin of milk is regarded not only as a nutrient but as a carrier of anti-bodies or other immunising factors from the mother to the new-born. The energy-producing factors of milk-fat, protein and sugar, should be given the importance they deserve for the energy-values which they possess in common with many other food products. But the special value of milk as a growth-producing and health-giving substance is independent of its fuel value.

1113. Colostrum : The globulin (lactoglobulin) of the colostrum is identical with the serum globulin of the blood. Colostral-fat also shows a difference from milk-fat, containing, as it does, a greater proportion of capryllic and capric acids. The fat of the first colostrum contains nine times the carotene, eight times the vitamin A and twice the vitamin D of the normal butter-fat. Colostrum, as has been said, is responsible for passing over maternal anti-bodies to the off-spring. Bacterial agglutinins also pass over from colostrum to the new-born and rapidly get mixed up with the blood. The anti-bodies conveyed by the colostrum to the new-born are important for its safety. In the absence of colostrum pathogenic bacteria invade various organs of the body and blood poisoning results in the calf. While the foetus was in the

placenta, the cow could not pass the anti-bodies to the foetus through the placental barrier. Hence the great necessity of feeding colostrum after the off-spring is born. (1011) Mr. Sayer managed to rear calves depriving them of the natural protective feed of colostrum. He was fortunate, but it must be said that he ran a very grave risk. It was held formerly that colostrum was a sort of laxative designed for pushing out the accumulated excreta 'meconium' of the young. In the special handling of the Pusa herd, it has been shown that calves continued to thrive well when the colostrum was drawn out by pre-natal milking. The calves were fed with ordinary milk with the addition of an ounce of linseed oil per day. It was a lucky thing that it so happened at Pusa ; but such luck may not befall all calves. Colostrum provides anti-bodies which save the calf from bacterial invasion from within the stomach and from outside. It turns to normal milk in about a week's time. The protective value of milk is not confined to the colostrumal milk period only. It, in its normal condition, is much more than what its food or energy-value and protein-values are. Milk is something much superior to its component nutritional factors.

Milk supplies the complete proteins necessary for body-building. There are some amino acids that are essential and some are non-essential. It has been hitherto difficult to completely separate the essential from the non-essential. Milk protein, however, is a complete protein, and it allows the formation of new

proteins for building, and also for replacing those lost by wear and tear.

1114. Calorific value of milk : Milk from European cows gives 310 calories per pound. Of this, fat accounts for about 50 per cent, protein 21 per cent, and lactose 29 per cent. But in the Indian cow-milk, fat accounts for much more and the total caloric value is also greater than 310. The energy-value of fat per 100 grams of milk having 4.5 per cent fat is 82.5 calories. On this basis one pound of the Indian cow-milk having 4.5 per cent fat would have 531 calories out of which 371 calories would be accounted for by fat and 160 by proteins and lactose.

1115. Vitamins in milk : Milk is an important source of vitamin A. But its quantity depends upon the feed received by the cow. If the cow is stall-fed on dry straw and such other dry stuff only, without shade-dried hay or silage there will be little vitamin in the food of the cow. The cow will suffer from vitamin deficiency and the milk of such a cow will not at all be helpful as a source of vitamin A which it may contain only in traces.

Commercial processes have been in use for artificially increasing the vitamin-D-content of milk by subjecting milk to irradiation. It has been advocated to feed the cow with products such as irradiated ergosterol in order to get more vitamin D in the milk. This process ensures more vitamin D in the milk but the price is prohibitive. The presence of vitamin A in the milk helps the generation of vitamin D under irradiation. (612)

1116. Characteristics of milk : Milk is a white fluid. The whiteness is due to the scattering of reflected light by the ultra microscopic particles of fat globules, colloidal calcium caseinate, and calcium phosphate. When carotene is in the milk to an extent, the whiteness is modified to creaminess by the colour of carotene dissolved in the fat.

Separated milk has a blue tinge. The depth of blue varies with the fat remaining in the skimmed milk. Blueness is intensified by the dilution of skimmed milk with water. By processing the whiteness is intensified owing to the destruction of blue colour.

Milk is an emulsion of fat in a colloidal solution of casein in the plasma-containing lactose. This emulsion shows its peculiar surface tension which is lowered by the increases of fat-content. There is a sort of capillary attraction on the surface of the fat globules, and there the soluble substances of milk accumulate and lower the surface-tension.

By an increase of dissolved air in the milk, the surface tension increases, whereas development of acidity on changing the physical property of calcium caseinate decreases the surface tension.

Milk readily froths in the milking pail or on stirring. Froth is gas, an enormous area of which is enclosed in a very, very thin layer of liquid. This condition is attained by the lowering of surface tension which allows a thin layer of colloidal solution to spread in thin films—the films being sufficiently elastic

and tough to prevent the coalescence of the gas globules. The dissolved gases, carbon dioxide and air of the milk, help this.

FAT SEPARATION: The separation of fat from the milk is possible because of the difference in the density of the milk-fat, .92 to .94, and of milk serum which is over 1.03. The viscosity of milk retards the separation of fat. But for this viscosity fat globules would rise up as they do when oil or fat is with water. Yet viscosity is not everything ; for, by increasing the viscosity by the addition of gelatin, fat rises quicker. Increasing the viscosity of milk by gelatinous substances gives a better separation of the cream. But if the viscosity of milk is increased by the addition of non-colloids, such as sugar, it delays creaming. Homogenisation is the name given to the process of breaking up of fat globules by passage through capillary orifices at great pressure. When milk is treated in this way, the effect is that of a great retardation of fat separation. Homogenised milk, therefore, separates with great difficulty.

When milk is allowed to stand, cream separates and rises on the top. If this layer of cream is taken off, what is left is called skim-milk. But much fat is left in the milk itself in this way. For more complete separation of cream than can be attained by gravity, the help of churning by hand-churns or cream separators is taken. The velocity of separation is influenced by the centrifugal force exerted. The action is the same whether done by hand-churns or centrifugal separators.

Machine separators of cream run at a speed of 6,000 revolutions per minute. The force of separation depends upon the mass of the contents of the bowl, on the diameter of the bowl and on the speed of the revolution. The cream rising to the top is taken out by a draw-off, whereas the separated milk is drawn off by another draw-off a little distance away. The difference in the distance between the two can be regulated, which also regulates the volume of cream in proportion to the volume of separated milk when a constant stream of milk is fed to the bowl. Separation is best done at a temperature of 90-110° F. Below the lower limit viscosity increases and greater resistance is offered to the separation of fat globules.

When cream obtained from a cream separator is churned, the fat globules aggregate and clump together. The clump growth is accompanied by increasing viscosity. The clumped fat goes to make butter.

1117. Acid character of milk : Acidity of milk is expressed in terms of lactic acid. In the freshly-obtained milk there is no lactic acid formation, yet there is some acidity which is expressed in terms of lactic acid. By keeping milk, due to auto-oxidation, some fat breaks up into fatty acid which gives an acid taint to the milk and which may ultimately develop more. This acidity due to the separation of fatty acids of fat is also expressed in terms of lactic acid. Finally, lactic acid develops on keeping milk, and goes on

increasing by the breaking up of the lactose-content of the milk. The acidity of fresh milk varies from 0·1 to 0·18 per cent. When acidity increases by lactic acid formation to 0·26 per cent, then normal milk coagulates on heating.

1118. Coagulation : Milk is coagulated by the action of rennin and by the development of lactic acid bacilli in the mass of the milk itself, as in *dahi*. Milk coagulates by heating also, as in *khoa*. In the manufacture of *khoa*, advantage is taken of the fact that when a particular concentration is reached, agitation in contact with the air coagulates the milk. The point of coagulation in the making of *khoa* can be observed by an abrupt change in the colour and consistency of the mass under manipulation, towards the end of the process. This point is reached when evaporation brings milk to the consistency of butter. The ratio of concentration is 4·5 to 4·8 when the total solid contents go up to about 60 per cent. The protein in this process loses solubility and milk cannot be rebuilt by mixing *khoa* with water because suspension-stability is absent.

1119. Pasteurisation of milk : The aim is to destroy the disease-creating organisms in the milk and also to arrest the multiplication of micro-organisms which may render milk unfit for human use. By pasteurisation the keeping quality of milk is enhanced, although at a cost which is of doubtful utility. Usually pasteurisation is done by the 'holder' method. Milk is heated up to 62·5—65°C. and is held at the temperature for half an hour. After this period, the

milk is cooled and bottled for delivery. There is another method—"flash pasteurisation." In this process milk is raised quickly to 75°C . and is kept at this temperature for thirty seconds and then quickly cooled.

These processes are for the Western countries where boiling of raw milk before using is not the practice. In India milk is invariably boiled before use and, therefore, no useful purpose is served by pasteurisation. The slight increase in the keeping quality by pasteurisation is not of much consequence in India on account of the high atmospheric temperature favouring rapid growth of bacteria at ordinary temperature, even after pasteurisation.

For Indian conditions boiling milk and keeping it at a suitable warm temperature is the best method of keeping liquid milk. As compared with pasteurisation, boiling and keeping at an elevated temperature is the cheaper method of prolonging the time for the sale and distribution of milk. Milk keeps at 150°F or 66°C . for a longer time than at the ordinary temperature of the atmosphere.

1120. Nutritive value of milk : There is no effective substitutes for milk in the human dietary, particularly in the dietary of infants and of growing children. Milk is designed as a perfect food up to the age when foods other than milk are not digestible. In infants six months is the age limit for the use of milk as the sole nutrient. Because of its iron-deficiency nutritional disorder appears if the diet consists exclusively of milk after six months of age. For

any age, however, milk is an invaluable item of nutrition.

Calcium and phosphorus are largely present in cow-milk. Babies brought upon cow milk show more development than those nursed on the mother's milk alone. This can be accounted for by the higher content of calcium in cow-milk.

Milk added to cereal diet causes satisfactory growth and contributes greater success in rearing the young. The energy of the feed, whatever be the source, is better utilised with an ample provision of milk in the diet. Milk is pre-eminently one of the most powerful protective foods. Even a little of it in the food does a great deal.

1121. Milk and growth of children : Growing children need milk. Human beings take more time to grow than other mammals. Up to 21 years, growth continues for them. During this period, if there is any deficiency in nutrition, the inclusion of milk even at a last stage serves partly to correct the past fault and make up for the deficiency.

With growth well established in early life by the abundant use of milk, early mortality is prevented. There is less of infantile mortality, better teeth, greater vitality; better reproductive ability and longevity are assured by the use of milk.

All over the world, it has been the custom to watch the growth of children under the fostering influence of milk. In our country also some experiments have been conducted with results at a par with the results of experiments elsewhere.

Wright gives the following two Tables in his Report :

TABLE—114

Effect of a supplement of whole milk on the growth of school children.

Groups.	On Milk.				Control.			
	Average gain in 3 months.		Average gain in 3 months.		Average gain in 3 months.		Average gain in 3 months.	
	Boys.		Girls.		Boys.		Girls.	
	Wt. lbs.	Height. inch.	Wt. lbs.	Height. inch.	Wt. lbs.	Height. inch.	Wt. lbs.	Height. inch.
I	3·92	0·80	5·35	0·78	1·60	0·60	1·1	0·18
II	3·90	0·70	4·33	0·38	1·56	0·46	1·1	nil
III	3·70	0·53	3·00	0·19	1·90	0·42	1·0	0·07
IV	...	...	5·50	0·29	...	...	0·5	nil
Average	3·84	0·67	4·54	0·41	1·6	0·49	0·92	0·06

TABLE—115

Effect of the supplement of skimmed milk on the growth of school children.

		Average increase in weight in 3 months.	Average increase in height in 3 months.
Hostel 1 (Boys)—			
Group	A (receiving milk)	4·77	0·61
„	B (not receiving milk)	2·13	0·35
„	B (receiving milk)	3·07	0·69
„	A (not receiving milk)	1·00	0·43
Hostel 2 (Girls)— Girls receiving milk		4·8	0·80
	Girls not receiving milk	0·8	0·53
Hostel 3 (Boys)— Boys receiving milk		4·57	0·67
	Same boys not receiving milk	0·84	(?)

It will be seen that girls increased at a greater rate than boys, probably because of greater mal-nutrition in the past. It appears from this Table that skimmed milk was as good as whole milk. This has been the experiences elsewhere also.

“...Orr, Leighton and Clark, found that the addition of whole milk and separated milk respectively to the diets of school children attending day schools in some Scottish towns promoted satisfactory growth, and separated milk proved as beneficial as whole-milk; the latter effect may be referred to the mineral-content of milk rather than to the vitamin-D-content (which would be small in any case). The extra supply of calcium salts would also enhance the value of any vitamin present in the diet.”—(Davies.—*The Chemistry of Milk*, 1939. P. 499). (496)

1122. Free milk in Municipal schools: The Report on the Marketing of Milk went on to say :

“The New Delhi Municipality have continued the scheme by providing about Rs. 1,600 annually in their budget for distribution of free milk to school children. This sum is unfortunately sufficient to provide milk only to 50 children out of over 3,000 in their schools. Although the chief medical officer has made several appeals to the parents to join the scheme on payment, it is understood that only about 35 other children have taken to it.

“The experiment has aroused interest in adjoining areas, and the United Provinces Government are also studying the effects of feeding milk at some

of their schools and sanctioned Rs. 9,000 for the purpose during the year 1939-'40. In view of the encouraging results of the experiment in South India and in order that imported skimmed milk powder may be available more cheaply to the poorer classes, the Government of India from June, 1939, fully exempted skimmed milk powder from the import duty, which was 25 per cent *ad valorem*. It is reported, however, that cheaper skimmed milk powder is used more extensively for adulteration purposes rather than for the feeding of school children."—(P. 76-'7)

The problem of mal-nutrition is not confined to the school-going children of some of the cities of India alone. At Delhi 50 students consumed Rs. 1,600/- worth of milk per year at the rate of 1 lb per day, or, each student had to be fed with Rs. 2/8/- worth of milk (15 seers) per month. What would the Rs. 9,000/- of the U. P. Government do or the Rs. 1,600 of the Delhi Municipality do in face of the country-wide necessity? Village school children do also require milk to supplement their food. Gratuitous and Government undertakings cannot solve such problems.

1123. Free milk in basic schools : The basic education scheme initiated by Gandhiji fits in admirably into the proper way for meeting these requirements. Let every basic school for boys of 7 to 14 years of age be an agricultural and dairying school. Let the school boys and girls maintain a set of cows. Let the school dairy make butter and *ghee* for sale, and let the school children get the skimmed milk or *lassi* in exchange

of their labour. All these are possible with an altered outlook on problems of national nutrition and education. They are all connected one with other. Such basic schools will be the replica of the schools of the old days when students offered their personal services to their preceptors and got their education. The boys had to tend the cows of the *guru*. This they did and they got their food and milk also from the house of the *guru* which was their own home for the time.

It has to be remembered that men and women, boys and girls, and the cattle all suffer from mal-nutrition in India. There is no half way solution of the problem. Radical steps are necessary for removing the evil.

1124. Milk diet and longevity : Apart from helping growth milk-diet ensures health to adults and is conducive to longevity.

"It is interesting to note the relation between long life and the habit of taking plenty of milk. It has been ascertained in Germany that out of a total population of sixty millions only 100 inhabitants are aged 100 years or more. It has been proved from data collected by the Pasteur Institute at Paris, that in Bulgaria, with a population of about 5 millions only (i.e. about one twelfth of the population of Germany) nearly 5,000 have a life of one hundred years or more. The reason of this is undoubtedly the nature of the food the Bulgarians take. The Bulgarians take a very large quantity of milk, cheese, joghurt (*Dahi*) in their daily food, whereas flesh diet is taken only on holidays."

—(Godbole.—*Milk—The Most Perfect Food*. P. 49)

CHAPTER XXV

MILK PRODUCTS

1125. **Ghee**—a naturally suitable product: Milk is a medium which is very well adapted for the growth and multiplication of bacteria. There are so many of them out in the air that uncared-for milk will harbour any of them and allow their unchecked multiplication which will decompose or so alter the milk as to make it unfit for human consumption. In India, therefore, boiling the milk and then keeping it hot is practised for keeping fluid milk in a healthy condition for several hours before consumption. This is a most commendable practice and suits the requirements of the people and the condition of the climate as well.

Beyond this, milk is converted into some other products. In this matter also, as in the case of pasteurisation, enterprisers have been after copying the methods of Europe and apparently without much success.

Indians take butter-fat in the form of *ghee*. Europeans take the fat in the form of butter which is far more difficult to keep than *ghee* and requires expensive canning for storage and distribution. It is used in few Indian families; its demand is very limited. Indians have little taste for cream and, therefore, the manufacture of cream, the manufacture of table butter, is not a popular industry.

Some fat is taken in the form of butter in India. But that butter contains more water and is not preservable like the tinned butter of the West. The process of making such butter forms an intermediate stage in the manufacture of *ghee*. Fat is preserved and used universally in India as *ghee* which has keeping qualities and may be stored for months or even for two years, if proper precautions are taken in its manufacture and storage. *Ghee* does not require to be retailed out as soon as a large container is opened. It can be kept a long time in an open condition and slowly retailed out or used.

There is another advantage in the manufacture of *ghee*. It is very largely made by converting milk into *dahi* and then churning the *dahi* which makes the fat separate and float up. The fluid that remains behind is called *lassi* or *ghol*. This fluid contains all the nutritive materials of milk except the fat and the vitamins that are fat-soluble. *Ghee*-manufacture is mainly a cottage industry. The by-product of *ghee*, *lassi*, is hardly a by-product, for its nutritional value is no less than that of the *ghee*. All the proteins, the lactose and the mineral salts are left behind. In the cottage-manufacture of *ghee* this rich secondary product is used in the home as it is made. The produced *ghee* is stored either for future use or for sale. Therefore, even if *ghee* goes out of a cottage for sale outside, fifty per cent or more of the nutritional value of the milk is utilised within the cottage.

On account of this natural suitability to the conditions of life of India, *ghee* has become so popular

an article of diet. It enriches those who buy the *ghee*, and it enriches those who produce the *ghee* by allowing them to use the fluid left over.

It has been shown that only 28 per cent of the total output of milk is consumed as fluid ; 57 per cent is converted into *ghee*. These two items account for (28+57) 85 per cent of the total milk production. The remaining 15 per cent is divided into three thirds—one-third or 5 per cent goes for making *khoa*, another third or 5 per cent goes to make *dahi*, and the last third or 5 per cent goes to make the various minor milk-products—such as sweetmeats like *sandesh*, *rosogolla*, *kheer*, *malai*, *rawri*, and various other products to be found in a sweetmeat shop, and also for making some cream and ice-cream and butter. (276)

1126. Importance of *ghee* : Of all the milk-products in India *ghee* is of prime importance and the most important article of trade. The Report on Marketing of Milk (1941-42) said :

“It keeps good for long periods even under tropical conditions of storage and ordinary packing. This accounts for its extensive manufacture. The few available results of keeping quality tests show that well-made *ghee* can remain good for about two years and can be reconditioned by clarification. No other indigenous product keeps so well and for such a long period, nor can it be reconditioned likewise.”—(P. 67)

The 57 per cent of milk that goes to the making of *ghee* is an all-India average. There are certain provinces such as the Punjab and Bihar where

77 per cent of produced milk goes to the manufacture of *ghee*. Orissa also is to be bracketed with the Punjab and Bihar. In Bengal, on the contrary, on account of the less production of milk 31 per cent only goes to the manufacture of the *ghee* of commerce. It is very largely imported from other provinces into Bengal to meet her needs.

The value of *ghee* manufactured and sold has been estimated at one hundred crores of rupees.

That 57 per cent of fluid milk is utilised for making *ghee* shows the importance of *ghee* in our rural economy. Of the many milk products *ghee* constitutes 79·2 per cent. Its wide production as a cottage industry shows the suitability of *ghee* manufacture to Indian conditions. By no other method could the fat and fat-soluble vitamins of milk be kept fit for storing in a sterile condition without any special package at all.

“There is no need to stress the value of the principle of separating and storing the fat of milk for use later as human food. It is the most rational form of fat-fraction to be made under Indian conditions so as to combine keeping quality with domestic methods of cooking, which are practised also with easily-available pure vegetable oils and fats....” (Davies.—*Indian Indigenous Milk Products*. P. 40). (276, 280)

1127. The cottage process of ghee making : For the cottage manufacture of *ghee*, milk is allowed to set to *dahi* with the help of a starter. It is heated to boiling which kills all bacteria and is then allowed

to cool to luke-warmth. At this stage the *dahi*-starter is added and the milk allowed to coagulate for one to three days or more. By longer stay more lactic acid is formed and the acidity of *ghee* increases.

Yet this making of *dahi* is a great safety to the cottagers. There is no imperative necessity of churning the *dahi* within a short and specified time. The collection of *dahi* for several days may accumulate to render the quantity suitable for churning.

When *dahi* is a little old and the quantity necessary for a churning operation has accumulated, then it is churned. It is placed in a vessel and a pole to which beaters are attached is turned with the help of a rope which passes round the pole in a loop. The pole is held erect by having it passed through two fixed loops against another pole. The free ends of the rope are pulled from one direction to the other, and this gives a whirl to the pole with its attached blades. The *dahi* breaks up and fat floats up and collects against the pole. The lower the temperature of churning the greater is the yield of fat. Churning is, therefore, done in early dawn. In the hot weather the yield is less unless the *dahi* is specially kept cool. — Water is added to help the separation of fat. The floating and clustered fat is taken out which keeps some casein encased in it. The extracted fat is worked up into a mass and washed to free it from the casein and also from other soluble matters. This partly-washed butter contains a large percentage of water. It is necessary to beat out and separate further water from it. The lump of crude butter is stored, mixed with

the quantity obtained in any previous operation till a sufficient quantity accumulates for one charge of clarification. The remnant left after churning is the *lassi* which is used as a nutritious food material.

1128. Clarification : Clarification is the separation of butter fat from all adherent casein and water. It is done in an iron pan. Heat is slowly applied till the butter melts. On further heating the temperature rises and the molten mass begins to clarify. On brisk boiling for a while all the water evaporates off and a scum appears on the surface which is removed with a perforated ladle. The particles of casein now begin to char and globules are seen in the convection current set in. This is the indication of the finishing. A peculiar aroma characterises the end point. During boiling, the temperature of the mass is kept regulated by putting in and withdrawing fuel from under the pan. The hot *ghee* is then poured off into a vessel, usually an earthen-ware *ghara* or tinned iron vessel. The half charred globules of casein and salts remain at the bottom of the pan which is carefully drained out. This is the *kuccha ghee*. As a commercial article, it occasionally retains more moisture than it should. It is collected by dealers, bulked and melted for canning as the finished commercial product.

During bulking only a re-melting is generally necessary. The liquid is transferred after filter through *muslin* or directly. If the *kuccha ghee* was under-done, heating is continued till the proper temperature is attained. A suitable temperature is

110° C. At this temperature no moisture is left in the mass, and at the same time undue charring and development of charred odour or colour are prevented.

1129. Ghee from cream and butter: When milk is converted to *dahi*, and the fat is separated by churning, the whole of the fat does not come out. The addition of water helps greater separation. Yet, some fat is left in the fluid which becomes the richer for it. This *lassi* is the village milk for those who cannot afford to keep their whole-milk for themselves. If milk is separated in a cream separator almost the whole of the fat of the milk is taken out and fat-free skimmed milk is left behind. In Bihar, cream separators have penetrated into the villages, and in every cluster of villages in the milk-producing area there will be found a creamery which is really a cream-separating establishment. These are worked independently by the village enterprisers or are set up as collection places for the *ghee* concerns. Milk is brought to the creamery. After separation, the separated milk is returned and a price, depending upon the value of the cream, is paid. There is a relationship by which *ghee* price is regulated to the price of the cream. A quantity of cream in the establishment is then put into churners. (1170) A churner is a barrel mounted on a stand and table to revolve on its short axis. The lid can be opened and closed by the simple contrivance of a set of levers and tightening bolts and screws. There is an window for observing the condition of the separated butter and a draw-off plug.

The cream is put in the churn and kept rotating with the help of the handle. This gives a splashing and breaking action to the fat-globules which collect in a clump. After proper operation and washing the churner is opened and the butter taken out. The consistency of such butter is kept constant, and it is definitely known how much of this butter will give a fixed quantity of *ghee*. The owner of the creamery sells the butter to the dealers who melt and clarify it into *ghee* in the same way as is done with butter obtained from *dahi*.

1130. Ghee directly from cream : A third method of directly boiling the cream to clarify it into butter is adopted in certain places. In this case the cream separated from milk by a cream separator is immediately clarified into *ghee*. The boiling process is the same as with the previous ones, only the difference is in the quantity of embedded casein found in the cream. On making butter the bulk of the casein is practically washed out, and on melting the deposit is not large. But in melting cream and directly clarifying it into *ghee*, the casein remains and after clarification keeps absorbed in it a quantity of fat which is lost. The yield of fat is said to be less in this case. But the conversion of sweet cream into *ghee* gives its own particular aroma to the product, and there is no chance of the formation of any acid bodies in the final product. Naturally, this improves the keeping quality of *ghee*,

1131. Intermediate souring of cream : There is yet an intermediate process of making *ghee* from the

cream of separated milk. Here the separated cream is allowed to be soured with the help of a starter, and lactic acid fermentation is allowed to proceed to give the required acidity and aroma. The soured cream is then churned into crude butter and melted into *ghee*.

In creameries where milk is so collected that the return of skimmed milk is not possible, the operation turns to be a wasteful one. In such cases the skimmed milk is treated to make casein out of it. Such casein is not sold as a food-material but goes to the various factories for utilisation as an industrial plastic or glue. The lactose and mineral salts are wasted. The recovery of lactose is difficult without the aid of large plants ; this is being done in certain concerns.

1132. Ghee flavour and aroma : Different provinces and different districts have preference for particular flavour and aroma in the *ghee*. Once the peculiarity of the desired flavour is known and the method of manufacture studied, it is not difficult to keep the aroma and flavour constant for the satisfaction of the consumers.

The aroma is a combination of several components. There is the butter flavour, there is the butyric and other volatile acid flavour, and lastly there is the slightly burnt casein flavour which predominates and blends the other two factors.

In *ghee*-production through lactic fermentation of the *dahi* some lactic acid-like substance gets dissolved in the fat. The conditions required are liable to be controlled both during the *dahi* production

and during clarification. The ripening of this cream also has to be regulated to the same end.

1133. Granular texture of ghee : The texture of *ghee* also is a matter to which importance is attached by the consumers. After melting, the *ghee* can be granulated to a variety of textures according to the rate of cooling. If the temperature is very slowly lowered and the *ghee* kept undisturbed, large granules can be obtained. On the other hand, quick cooling or agitation during cooling gives a mass of small granules. The preference of consumers is generally for the large granules. There is a proportion between liquid and granules in *ghee* which varies according to the season and the atmospheric temperature.

The destruction of some fatty acids of lower boiling point by the prolonged action of lactic acid bacilli may cause the liquid fraction of *ghee* to diminish. The subject has not yet been thoroughly investigated. In marketing, the local demand of consumers shapes the manner of varying the crystal or granular appearance of the *ghee*. The presence of un-saturated fats as revealed by iodine value also affects the proportion of granules in a mass of *ghee*.

1134. Colour of ghee : Cow-*ghee* is yellowish. This colour is due to the carotene-content of the *ghee*. Buffalo-*ghee* is white because of the absence of carotene in it. When the carotene is converted to vitamin A, the colour becomes fainter, so that a light-coloured cow-*ghee* may contain less carotene apparently, while the increased quantity of vitamin is not detectable from appearance.

The composition of cow-*ghee*. (*Godbole and Sadgopal*).

Fatty acids.			Per cent.
Butyric acid	...	...	4
Caporic acid	...	...	2
Caprylic acid	...	...	1
Capric acid	...	...	2
Lauric acid	...	...	4.5
Myristic acid	...	...	10
Palmitic acid	...	...	26
Stearic acid	...	...	10
Oleic acid	...	...	34.5
Linoleic acid	...	...	5
Unsaponifiable	...	...	1

1135. Assimilability of ghee : Of the fatty acids those mentioned earlier in the above list are of simpler composition beginning with butyric acid ; they are easily absorbable. Those lower in the list, such as palmitic and stearic acids, are hardly absorbable by the human system. The last ones, oleic and linoleic acids, are what is known as unsaturated acids. They play a significant part in animal nutrition and are assimilable.

It is difficult to say which factors contribute to the nutritional value of *ghee* and their extent. There are fats and fats, and on the mere standard of assimilability, other fats may excel *ghee*. The fuel-values would be proportionate to assimilability. This being the case, it is not easy to say wherein lies the superiority of *ghee* as an article of diet. But *ghee* has held its place these thousands of years side by side

with vegetable fats and other animal fats, as a superior article of diet.

1136. Nutritional value of ghee : We know now that cow-*ghee* contains a very large amount of carotene, the precursor of vitamin A, and also vitamin A itself. This is lacking in the buffalo-*ghee*. (520) If a fat is to be prized for its assimilability then *ghee* should yield place to cocoanut oil. But if fat is to be prized both for its assimilability and carotene-vitamin-content, then only cow-*ghee* remains and buffalo-*ghee* goes out of the picture to take its place along with the vegetable oils.

The presence of the large quantity of vitamins places cow-butter and cow-*ghee* in the same nutritional category as cod or other fish liver oils. But it may be, that its carotene-value and vitamin-values are not all ; but the combination of the absorbability with carotene-vitamin may have much to do with the high place that cow-*ghee* occupies in our dietary which cannot be argued out or assailed by well-directed and powerful propaganda from the interested manufacturers of artificial fats of dietary—for example, margarine. If margarine or cocoanut oil were to be mixed with a certain quantity of vitamin, they are yet likely to fall short of the genuine cow-product.

The manufacturers of margarine published plenty of literature to prove that margarine is as good as butter. In spite of that, margarine has to enter the market by the back door, taking the appearance, colour and flavour of butter. So much so, that legislation defines that certain statements have to be

made on margarine packages to show that it is not a cow-product. And margarine has not been able to touch the butter market.

Law has kept pace in the West with the skill of the manufacturer to pass off an artificial product as genuine. But in India this sort of unscrupulous dealing has not been able to awaken the Government to give legal protection to the genuine article. There is a nominal protection against adulteration, but it is only nominal, and the fraud goes on, in which the genuine article is elbowed out and cheap adulterants take its place. (109-'27)

1137. Comparative assimilability of fats: As regards assimilability the position will be made clear from the following Table from Godbole and Sadgopal.

TABLE—117

Some non-assimilable and assimilable fats.

	Non-assimilable palmitic and stearic glycerides. %	Assimilable oleic and linoleic glycerides. %	Easily assimilable lower fatty acid glycerides %
1. Beef tallow	52	46+	2 = 100
2. Mutton tallow	55	42+	3 = 100
3. Lard	40	60+	0 = 100
4. Buffalo butter-fat	44	34+	22 = 100
5. Cow butter-fat	36	40+	23.5 = 99.5
6. Cocoanut oil	9	11+	80 = 100

The above Table clearly demonstrates that as regards assimilability cocoanut oil stands first. It has 80 per cent easily assimilable and 11 per cent

assimilable or total 91 per cent assimilable fat, while cow-*ghee* has only 23·5 per cent easily assimilable and 40 per cent assimilable totalling 63·5 per cent total assimilable fat. The food-value as between these two on the score of assimilability would stand as below :

Cocoanut oil	...	91
Cow <i>ghee</i>	...	63·5

or as 3 : 2, cocoanut oil being about 3 : 2 times richer on this score. There is no comparison between the prices of the two, cow-*ghee* being nearly 4 times as costly as cocoanut oil.

The data are not available to show what difference in cost there will be between the same weights of cocoanut oil and *ghee*, if some vitamins were artificially mixed with cocoanut oil to equal *ghee*. Whatever be the difference in price, the difference in quality will be allowed to remain so long as we have not probed into and gauged fully the peculiar place that milk and milk-products take in animal nutrition.

1138. Ghee—its keeping quality : The keeping quality of *ghee* depends upon its acid-content, on its moisture and on its exposure to light. There is also another factor, namely contamination with copper or heavy metals.

1139. Copper contamination of ghee : Let us take the case of copper contamination first. If milk or *ghee* is kept in copper vessels or if copper is allowed to come in contact with *ghee* at any stage of manufacture, some copper goes into solution. It is a dangerous article, for it begins to act upon the fats, decomposing them, and every fresh attack opens the

field wide for more extended attack. Copper-contaminated *ghee* will spoil very soon. Milk contains in itself a microscopic quantity of copper and this even may play some part in tainting the milk itself. But when butter is separated out from milk, the source of this taint disappears.

1140. Influence of moisture on ghee : If there is moisture left in the finished product then micro-biological action commences, the action being intense at the fat-water contact surfaces. *Ghee* is degenerated, loses its aroma and gradually becomes unsaleable. Care, therefore, has to be taken to see that no excess of moisture is left in the finished *ghee*. There need be no moisture at all in properly-boiled *ghee*. There is, however, a chance of over-doing the heating, as this will spoil the colour of the *ghee* and destroy its aroma. Aroma is such a delicate thing that it cannot be restored to its original condition by any amount of doctoring or bulking with fresh material. Whenever possible it would be advisable to use a thermometer for bulking *ghee* in large establishments and to see that the temperature does not rise above 110°C. *Ghee* can be heated up to 123°C. without spoiling, but it would be risky to allow it to get up near to that temperature in boiling. Even if, after proper boiling, the foots or the dregs and solid particles are allowed to mix with the *ghee*, their presence will be a fruitful cause of future deterioration.

A chemical method of making *ghee* moisture-free is recommended by Godbole and Sadgopal. When the boiling is finished some freshly-prepared anhydrous

sodium sulphate or anhydrous alum is to be thrown in and stirred with the mass. These salts settle down but absorb water while they are kept mixed and stirred with the liquid *ghee*.

Their utility depends upon the hunger for water of the de-hydrated substances. They want to take up water to form crystals. When crystals of sodium sulphate are heated and dried off water goes out of it. If this de-hydrated substance is presented to *ghee*, it seeks for moisture and if any moisture is present it is absorbed, making the *ghee* moisture-free. With careful handling the use of chemicals should be unnecessary, though sodium sulphate is itself a harmless substance.

1141. Ghee : its contact with iron : Contact with heavy metals does no good to *ghee* such as iron and nickel. Iron vessels have got to be used. But the surface in contact with *ghee* should be bright. If the surface is rusty, rust-containing iron will get dissolved and begin to create mischief. Tin has no action on *ghee*. But tin canisters may be rusty, and from there contamination may start. As little as 5 parts per million of iron brings about rapid deterioration, giving rise to fishiness or oiliness, and if there be some free acidity in *ghee*, as there remains in all *ghee* made from *dahi*, the mischief catches and spreads quickly.

1142. Free fatty acids of ghee : When made from *dahi*, *ghee* usually contains some fatty acids. This should be kept low. Under the usual conditions free acidity does not exceed the danger limit. Everything should be done to keep acidity low. In

Government specifications for Agmark *ghee*, the better varieties are not allowed to exceed 1·5 per cent free acid-content. For the general green label grade the specification is that the acidity should not be more than 2·5% expressed as oleic acid.

High acidity brings in the risk of quick rancidity and should, therefore, be avoided.

Acidity of *ghee* is expressed by points. A point of acidity means the amount of acid in 10 grams of *ghee* which is exactly neutralised by the 10th. normal sodium hydroxide. This is equal to 0·282 per cent.

The army requirement for *ghee* prescribes an acidity under nine points or less than 2·5 per cent. Ordinarily the largest number of commercial samples show acidity between 7 and 9 points. The limit for the creamery butter is 3 to 4 points.

Acidity in *ghee* comes not only during its formation at the *dahi* stage but even after that when crude butter is stored prior to boiling. It is increased by storage. *Ghee* of 2 years standing may show increased acidity by 7 points. This increase is greater in the hot weather.

1143. Sunlight & the keeping quality of *ghee* : The effect of sun-light on the keeping quality of *ghee* is disastrous. People who are in the habit of keeping it in glass jars or bottles should take note of this.

If there is some moisture present, if there is metal admixture present or if there is acidity, all their effects will be magnified by the action of sunlight at a progressive rate. *Ghee*, therefore should be exposed

as little as possible to diffused day-light or direct sun-light. In the winter, when the *ghee* solidifies, it is no good to keep the opened vessel in sun-light for softening the mass for convenience of withdrawal from the container. Heating over water-bath is the best way of melting *ghee*.

1144. Action of air on *ghee* : Air oxidises *ghee* and produces rancidity ; moisture and air together act simultaneously, and either of these may act separately. Keeping open a container of *ghee* in the moist atmosphere is to invite rancidity because moisture and air and light attack the exposed surface. But the mischief is not confined to the open surface only. The taint spreads in the mass afterwards.

1145. Inhibitory action of carotene on contaminants of *ghee* : As air, light, moisture and contamination of metals accelerate oxidation, similarly an opposite factor which exercises inhibitory action on the fore-going agents operate in *ghee*. It is the influence of carotene. Carotene destroys or inhibits the deteriorating and oxidising factors. Cow-*ghee* which is rich in carotene enjoys this inhibitory protection and is, therefore, likely to have greater keeping quality than buffalo-*ghee* under equal circumstances, for the latter has no carotene in it. (520)

When *ghee* is prepared with proper precautions and tinned with all care in rustless dry tins and sealed immediately after, there is little chance of the material developing rancidity, say, in a year. Any flaws may create trouble.

It has been observed that the addition of a little oleic acid promotes anti-oxidising or the inhibitory character in *ghee*, which is further enhanced by the addition of Kamala. (*Indian Journal of Veterinary Science and Animal Husbandry*, December. P. 361)

Ghee produced between November and March is better than the *ghee* produced during the rainy season. Monsoon-*ghee* is said to be of a distinctly inferior quality and does not keep well.

1146. The filling of tins : In filling tins with *ghee*, proper care should be taken to see that there is no adherent moisture in the tins. Even the moist atmosphere of a rainy day or a foggy day is bad for filling *ghee*. Every precaution should be taken to see that the air inside the tin is moisture-free before filling it with *ghee* for storage. This can be ensured by slightly warming the tin over a fire or a hot surface.

1147. Standard for *ghee* : *Ghee* just like milk varies in character with the breed of the animal, its feed, and with the climate and season. Therefore, it is difficult to fix standards which will be applicable to all conditions. Something by way of a presumption of purity has been attempted in fixing standards. *Ghee* can now be marketed under Government mark ensuring quality according to the standards laid down. As a major article of commerce, in some large centres of *ghee* production, the whole-salers can now, under arrangement with the Government, license their premises and employ the Government chemist and staff for seeing to the standard, they paying all the expenses. Under this system *ghee* is purchased by

the wholesaler which is kept in a godown under the control of the Government staff for examination. Any particular consignment falling short of the minimum standard has to be removed from the premises.

The accepted consignments are bulked according to the grades, the specifications of which are given below. The tins are sealed and a paper label is pasted on the place of sealing so that the tins cannot be opened without destroying the paper-label specifying the Government gradation.

TABLE-118

	Cow ghee. yellow label.	Buffalo ghee. blue label.	Special red label.	General green label.
Butyro reading at 40°C.	40.5—42.5	40.5—42.5	40.5—42.5	40.5—48.5
Moisture not more than per cent	0.5	0.5	0.5	0.75
Saponification value	222—226	226—234	222—234	220—236
Reichert Meissl value	26—28	not less than 30	not less than 28	not less than 24
Free fatty acid per cent not more than	1.5	1.5	1.5	2.5

1148. The utility of specifications: The specifications are designed to be such that if *ghee* is adulterated with vegetable or animal fats other than *ghee*, all the specifications will not be observed in *toto*. Somewhere the adulterated stuff will fail to come up to the standard. For example, if an oil is mixed in such a way that Reichert Meissl value is made to tally with the specification, it will be found that the mixture though passing the R.M. test will

probably fall outside the butyro refractometer reading requirement. These two tests generally cover most of the ground against adulterants.

1149. Butyro refractometer reading of ghee :
When a ray of light travels from one medium to another, there is a deviation in the line or direction of light. A stick put slanting in water looks as if it were broken and bent at the point where the stick enters the water. This angle of deviation from the straight direction can be measured. A microscope-like instrument is used for determining the angle of deviation of a ray of light passing into various liquids, supposed to be butter-fat. Butter-fat is kept melted in a thin film and the instrument adjusted to read the angle of deviation of a ray of light passing through it. Some figures are directly read on the instrument depending upon the angle of deviation. The reading for butter-fat comes within 40·5 to 42·5. The Butyro refractometer reading for some of the oils are given below. (*Godbole and Sadgopal*)

	Butyro refractometer reading at 40°C.	
Cocogem	...	34·2
Cocoanut oil (Cochin)	...	34·25
Olive oil	...	54·7
Sesamum oil mixed	...	59·0
Linseed oil	...	62·0
Mutton tallow	...	45·5
Beef tallow	...	49·0
Vanashpati	...	51·55
Margarine	...	50·3—58·2

It will be seen that no other oil can singly pass the butyro refractometer reading of 40·5—42·5 specified for butter-fat. But some mixtures may reach the butter-fat specification. Godbole and Sadgopal give examples :

Nature of fat mixture.	Refractometer reading at 40°C.
1. Lard, <i>ghee</i> & cocoanut oil ...	43·5
2. Tallow, <i>ghee</i> & cocoanut oil ...	44·0
3. Vanashpati, <i>ghee</i> & cocoanut oil	42·4
4. Tallow 10% & <i>ghee</i> 75%, paraffin wax 5% & cocoanut oil 10%	41·0

It will thus be seen that some of the mixtures of other fats with *ghee* fall within the range specified for it. The artifice is to keep *ghee* in the middle position and adulterate it with a mixture having a higher and lower reading. Cocoanut oil gives a lower reading and tallow or Vanashpati gives higher reading. A mixture so designed will pass as genuine *ghee* although adulterated, so far as the butyro refractometer reading is concerned.

R. M. is an arbitrary figure indicating in its own way the amount of steam volatile fatty acid present in the sample. The Reichert Meissl value of *ghee* has been put at 26 to 30 for different grades.

Reichert Meissl value for some fats and oils.

Cocoanut oil	...	6 — 8·5
Lard	...	0·3— 0·9
Tallow	...	0·1— 0·6
<i>Ghee</i>	.	26 —30

With regard to this it is apparent that the usual adulterants have very low values, but the trick can be performed by bringing in paraffin wax as an adulterant.

1150 Adulterated ghee passes the test: With regard to the adulterated mixture 4 of Godbole and Sadgopal, it is shown how closely it resembles the accepted *ghee* specifications, although adulterated to the extent of 25 per cent.

TABLE—119

*Values of adulterating mixture of Tallow 10 %,
Ghee 75 %, Paraffin wax 5 % and
Cocoanut oil 10%*

	Reading of adulterated sample.	Reading of grade ghee, green label.
Butyro Refractometer reading	41·0	40·5— 42·5
Reichert Meissl value	25·63	24 — 30
Saponification value	222·3	220 —236

From the above it will be apparent that a clever and dishonest trader will be able to so mix his article as to elude the Government specification and pass a 25 per cent adulterated stuff as genuine. As a matter of fact, the aid of a chemist is taken to fabricate *ghee* to reach the accepted standard for eluding fraud.

There are other defects in the Government standard. As has been mentioned, *ghee* specifications vary according to various circumstances, such as feed and breed. After the Government specification was made public, the merchants of Bombay and Kathiawar

came to prove that their genuine *ghee* fell far short of the standard in some details. The reason was mainly that the cows were fed with cotton-seed and oil-cake, and the butter-fat gave very different readings for this feed. After this the Bombay and Central Provinces Governments have come to specify a different standard.

Therefore, even at the moment, the specifications have a bearing on the place of origin of the *ghee*.

In a paper in the "Indian Journal of Veterinary Science and Animal Husbandry" March, 1940. N. S. Doctor, B. N. Banerjee & Z. R. Kothawalla show the following ranges of *ghee* constants as a result of their researches :

TABLE-120

	Cow.	Buffalo.
B.R. Reading at 40°C.	40.0 — 45.2	42.5— 43.6
Reichert value	23.0 — 30	30.2— 31.7
Poleneske value	1.9 — 3.0	1.5— 2.0
Kirschner value	17.0 — 24.2	26.6— 26.8
Saponification value	219.0 —230	229.0—239
Iodine value	29.0 — 42.3	30.8— 34.9
Free fatty acid per cent	0.21— 0.91	.....

These figures do not exactly fit in with the Government standard for Agmark *ghee*. The matter is engaging the attention of the Government, and Banerjee has been put in charge of research to be conducted at the Bangalore Laboratory on the fixation of *ghee* specifications.

Whatever may have been achieved by these specifications in the matter of adulteration of *ghee*, it has not touched even the fringe as a corrective.

1151. Adulteration of ghee : Some may question the advisability of mentioning the details of adulterating materials for making up a 25 per cent adulterated *ghee* without the chance of chemical detection under the existing specifications. It would have been so, were it not for the fact that the miscreants who carry on this injurious trade are not a group of resourceless novices. They adopt every facility for devising counter measures against the law regarding adulteration with the help of chemists, where necessary. The matter of adulteration of *ghee* has gone on to extremes. The law regarding foods stands inert, only threatening the more helpless and less resourceful men. The principal offenders manage to escape.

1152. Hydrogenated oils or Vanashpati : The principal blow to genuine *ghee* is coming today from the hydrogenated oils made by hydrogenation of fats and oils. Hydrogenation is a process by which oils, ordinarily liquid, can be converted into a solid product. The colour and odour of the oil disappear at the same time. It is called hydrogenation, because hydrogen is made chemically to combine with the oily material in the presence of a catalyst such as nickel. After hydrogenation the finished product is an almost colourless and odourless fatty body. Soap which requires a hard stuff like tallow to give it the required character may be conveniently made from hydrogenated oil. The degree of hardness to be

given to the product is at the hand of the technician as also the texture of the product. With such a material a technician may imitate any fat.

1153. Adulteration with Vanashpati: As a matter of fact, hydrogenated oil is produced to imitate *ghee* in every particular—colour, texture and crystal. Artificial perfumery is also at hand to give the required *ghee*-odour. A completely imitated product is available in the hands of the dealers who can adulterate *ghee* with it to any extent or pass the product in its entirety as *ghee* without having a trace of it in the finished product. Such a material which is known as Vanashpati or vegetable *ghee* will not answer the Refractometer test or the Reichert Meissl value of butter-fat. But this is no deterrent, for the law either does not exist or is sleeping.

To add to the difficulties, the *ghee*-test is a technical affair and cannot be conducted except at a specially-equipped laboratory. If, however, the Government willed it, hydrogenated oil could be made to answer a rough and ready test for detection, if hydrogenated oil is mixed with *ghee* or passed off as such. But nothing has been done. Wright mentions about "Vanashpati". This is the name which hydrogenated oil has taken—meaning of "vegetable origin" designed to pass off as *ghee*. It is supposed to be *ghee* only of vegetable origin. Hydrogenated oil is also marketed under the name of vegetable *ghee*.

Wright's exposition is lucid :

"There are no figures available which provide any estimate of the average amounts of adulterant added

to *ghee*. The chief fats used are "*vanashpatin*", "*charbini*" and certain pure vegetable oils, such as ground-nut oil, cocoanut oil and cotton seed oil. A very rough estimate of the quantities of adulterants used may be obtained from figures relating to the quantities of these products available in India. "*Vanashpatin*" is produced in 5 factories. The potential capacities of these factories (1937) is stated to be 33,000 tons per year, but the present out-put probably does not exceed 25,000 tons. In addition to this, about 1,000 tons are imported from foreign sources. It is the opinion of some of the manufacturers that about 90 per cent of the total supplies or 23,500 tons are used for the adulteration of *ghee*." (*Wright's Report*. P. 34)

This was in 1937. More factories must have sprung up since then. *Ghee*-adulteration by the so-called vegetable *ghee* or *Vanashpati* is rapidly on the increase.

The villagers even have come to know of it. Now, they are putting some of this stuff in the hot milk for making *dahi*. The added "*Vanashpati*" comes off as so much more butter, which is taken to the *ghee* boilers. Besides this, the wholesalers and retailers are busy utilising this material to make large profits. The pre-war price of "*Vanashpati*" was Rs. 12/- to Rs. 13/- per maund against Rs. 40/- per maund of *ghee*. Few can resist such a temptation, when the public cannot possibly detect the fraud without the help of an analyst.

In order to protect the consumer it was suggested to the Government to take the same step as has been taken in Holland to protect butter from adulteration with margarine.

Til or Sesamum oil has got the property of readily answering to a test, which needs the addition only of a little acid to it. A red colouration is produced. In Holland the law compels the hydrogenation factories to mix a certain quantity of *til* oil with the product. So that, if ever this stuff goes to be mixed with butter or any dairy product, a simple acid test will detect the fraud. I got the regulations current in Holland through the courtesy of the Commercial Intelligence Department. There was an agitation to adopt similar measures in India. But nothing happened, and the fraud continues unabated. In this connection it would be interesting to learn the the present position from the Report of the Imperial Council of Agricultural Research, 1941-'42.

"Prevention of adulteration of ghee with Vanashpati: This question has been engaging the attention of the Council for a long time. At its meeting held in July, 1941, the G. B. considered the following recommendations made by the Milk and Milk Products Committee and the A. B. on this subject.

"(1) The Food Adulteration laws should be extended to the whole of a province or state and their scope should not be confined to certain municipal or town areas only.

“(2) These laws should be administered more effectively, exemplary fines being levied on the delinquents where necessary. (It was desired that this should be specially brought to the notice of the Provincial and State Governments.)

“(3) Marketing Officers should be empowered to carry out inspection and collect samples under the Food Adulteration Acts.

“(4) All dealers, retailers and hawkers of *ghee* and Vanashpati or other hardened vegetable oils, should be licensed, and in granting such licenses, the same man should not be allowed a licence for both the products.”

Til oil admixture with “Vanshpatti”

“(5) It should be made compulsory on all manufacturers of hardened vegetable oils (such as Vanashpati) that they should, after they have been hydrogenated, add thereto at least 10 per cent sesame oil.

“(6) Vanashpati or other hardened vegetable oils should be retailed only in sealed tins with proper labels thereon.

“(7) Further research should be carried out with a view to improving the existing methods of testing and preparing *ghee* and butter.

“It was decided to communicate these recommendations to provinces and States and invite their views thereon as also on the feasibility of making the colourisation of Vanashpati compulsory without making it repulsive or unusable.”—(P. 53-’4)

1154. Detection of adulterants in ghee: The same Report of the Imperial Council of Agricultural Research had the following on a research work scheme for the detection of adulterants in *ghee*.

"...It has now been allotted to the Indian Institute of Science, Bangalore, under the supervision of Prof. B. N. Banerjee. The object of the scheme is to evolve simple and quick methods for the detection of adulteration of *ghee* by animal fats like lard, tallow etc., in addition to vegetable fats."—(P. 53)

The outrage of "Vanashpati" has gone so far that, not to speak of pure *ghee*, it is difficult to obtain even pure tallow or lard in the market. Good tallow fetches Rs. 20/- to 25/- per maund (pre-war). If "Vanashpati" at Rs. 12/- per maund can be passed off as tallow, there is every reason that pure tallow would be a rare article in the market.

1155. The adulteration goes on: Adulteration is rampant today. The matter of *ghee* is discussed above. The matter of raw milk adulteration is dealt with later on. The laws are there. They may be enforced. More stringent laws may be made and also stricter provision of enforcement may be made. But it is almost a futile race.

Price, and cheap price at that, has become the goal. This will go on creating the adulterating mentality with some subtle connivance from the users of adulterated articles, who want cheap products. In competition between the rival manufacturers, adulteration plays a great part, and each man is compelled to adulterate more on account of the

competition of that other man, who has gone in cheapening the price. And the public and the modern times require the cheap commodity. Thus the race goes on. Law can do something but not much in the prevailing atmosphere. Stringent law and their stringent application are good, but without a check in the race for the cheap commodity, law alone will be helpless.

1156. Change from cheap to fair price: The mentality is to be changed. Cheapness is not everything. By running after everything cheap—cheap education, cheap food, cheap clothes, cheap litigation and cheap success, we are racing for making life itself cheap and not worth living. The whole moral tone of the population is degraded by this craze for cheapness at any cost.

People should learn to care for costly things, for fairness in price. Cheapness hits back on fairness and ruins those who run after it. Let us learn to have a taste for costly things such as costly *ghee*, costly milk and costly education. Life will cease to be the shadow it has become under the urge for cheapness. Life will then be real, will be dear or costly and enjoyable, and that will automatically make the adulterating agents change their jobs for the creation of better things and trading in better things. Adulteration is a symptom. The law cannot cure the malady by going after the symptom alone. Deeper things are necessary—a change in the value of social life.

1157. Khoa or hard concentrated milk: *Khoa* is a soft solid obtained by concentration of milk.

It retains the entire nutritive materials of milk and is, therefore, superior to many other preparations. It cannot be re-constituted into milk by mixing with water because the proteins had become coagulated by the heat treatment. It is an excellent way of preserving milk and is very largely in use. In the hands of the sweetmeat-makers it is an excellent reserve material which may be utilised according to the fluctuation of the demand. It can be stored for four days or more according to the care with which it is stored ; mixed with sugar it can last very long, say, 3 to 4 months, according to the season. *Khoa* consumes 5 per cent of the total milk-production of India.

It is more popular in Northern and Western India. In the United Provinces and Sind it is a particularly favourite article. 11·6 and 9 per cent of the total milk production are converted to *khoa* in these provinces. It is said that the very large number of fairs and *melas* which are held in the U. P. have created this market for *khoa*, because during these occasions very large numbers of sweetmeat shops spring up and temporarily supply this nutritious material in large quantities. *Khoa* is a highly concentrated product, the concentration ratio being 1:6 or 6 seers of milk give one seer of *khoa*. As against this may be compared the concentration of the imported tinned condensed milks. Their concentration is only 1:2·5, or 1:2·4 or 1 lb. condensed milk represents 2·5 lbs. of whole or skimmed milk.

The manufacture of *khoa* requires considerable skill. 2½ seers of milk gives half-a-seer of *khoa*.

Only two and a half seers of milk is taken for concentration per batch, because larger bulk cannot be manipulated in the required manner towards the end of the stage, when vigorous stirring and scraping is required, coupled with close observation of the progress of concentration.

The milk is placed in a small round-bottom iron *karai* with a wire handle on each side. The iron surface is kept bright. The size is such that the vessel holds 12 to 15 seers milk. Milk is first put in the *karai* which is then put over brick-fire. A flat-ended stirrer, *khunti*, is used for stirring. The milk is brought to boiling, while the *khunti*, keeps the surface of the iron free from deposit by a continual scraping motion. By vigorous boiling with careful continuous stirring, the milk is not allowed to burn on the metal surface. The milk froths in the early stage of boiling. To prevent mischief, the fire is regulated by pulling off the logs of fuel or putting them in. After a time the milk begins ostensibly to thicken requiring more vigorous stirring. The point of coagulation is observed. Some drop a particle of alum which makes the end reaction smoother. In Gujarat and Kathiawar they put a little *dahi* or lemon juice in completing *khoa* cooking to serve the same purpose that the alum does. With or without alum, thickened milk on stirring and scraping over bright fire suddenly gets coagulated into a soft solid mass like butter. The addition of alum is not an essential requisite ; it only helps the process, which otherwise is done by heat alone. When still very soft, the *karai* is taken off from over the

fire and stirring is continued to allow the remnant of the moisture to disappear. The mass at this stage is collected at one part of the cooling *karai* and is then lifted out and placed on a piece of leaf. Each charge takes 10 to 12 minutes and pat after pat of *khoa* is stacked at the rate of 5 to 6 pieces per hour.

The rate of manufacture should be considered pretty quick, for about half a maund of milk can be made into finished article in about two hours. The operator's skill is the principal factor in the final appearance of *khoa*, which should present a smooth, slightly yellow surface, as prepared from cow-milk. Buffalo-milk *khoa* has a white surface. While the entire process requires skill, the main reaction is that of the coagulation of milk at a particular concentration.

Heat coagulation takes place when solid-not-fat contents are 40 per cent or total solid contents reach 60 per cent, or the concentration ratio of 4.5 to 4.8. The rest of the concentration follows during the finishing stage partly on the fire and partly when the pan is taken off from the fire.

On account of coagulation *khoa* has no suspension property, so that if it is broken up and stirred with boiling water, the material quickly settles down. The protein had lost its soluble stage and is in the form of heat-coagulated curd. It is a peculiar phenomenon that in spite of all the vigorous stirring and in spite of the destruction of the colloidal character of the medium, the fat-globules do not separate. There is no oiliness about *khoa*. We know that homogenisation

of milk by allowing it to pass through capillary orifices causes fat-globules to be kept dispersed. What is effected by such complicated mechanical appliances is accomplished simply by the skilful stirring of the mass in case of the preparation of *khoa*, in which the fat-globules are kept encased in the coagulum, and no trace of free fat can be found.

Khoa is an excellent article, suitable for preservation. When freshly-made it contains no bacteria or spores, because they are destroyed by the heat. It takes so little bulk that a five seer or one gallon vessel will be able to hold half a maund equivalent of milk. The lactose remains in the *khoa* in the form of fine crystals and the problem of the large gritty crystals of lactose, as occasionally happens in the case of condensed milk, is absent here. The deterioration that comes to *khoa* is entirely due to contamination. It is kept open on leaves, and moulds and bacteria find entrance into the mass. Moulds make greater mischief. The surface colour is affected first, giving an indication of the beginning of deterioration, then the whole mass deteriorates, becomes mouldy and unfit for consumption.

A cheap method of storing *khoa* in a sterile state is to add sugar to it. The product of a season of flush may be carried over to the season of scarcity and thus equalise the demand. Sugar is added while the mass is on the pan.

1158. **Kheer or thin concentrated milk :** *Kheer* is concentrated milk. The ratio of concentration is 1 : 3 or 1 : 4. The product is a viscous liquid.

Sometimes sugar is incorporated. Such sweetened *kheer* has a taste similar to that of condensed milk. It is much less suitable for storing compared with *khoa* and is prepared to meet only the day to day demand. Containing as it does a quantity of water, there is the possibility of lactose settling down to large crystals and making the product gritty, particularly in the unsweetened variety. It does happen occasionally, and the *kheer* tastes gritty. But usually, during the short period it is stored, there is little chance for lactose to form large crystals.

1159. **Rabri or sweetened clotted cream :** When milk is evaporated and cooled, a skin of cream forms on the top. When the milk is allowed to evaporate over a slow fire and the evaporation is hastened by fanning, skins of clotted cream form quickly. On this phenomenon depends the production of *rabri*. Milk is kept evaporating on a pan with a large surface and fanned for quicker evaporation. As the skin forms it is taken up by a thin needle-like stick (a bamboo splint) and placed against the side of the *karai* just above its milk-air junction. By remaining on the side of the *karai* the skin drains off and the entrapped material flows back to the mass of milk. Layer after layer of skin is taken and thus kept on the side of the pan draining. When the desired concentration of the remnant of the milk in the *karai* is reached a quantity of sugar is put into it to give a syrupy consistency. At this stage the skins are dropped into the hot syrupy mass and incorporated therein. Two ounces of sugar are used per pound of

milk. After the putting back of the mass of the milk-skin, evaporation is continued for sometime longer and then finished. The finished product consists of flakes of milk-skin in a thick syrupy sweetened *kheer*.

To those who can tolerate excessive sweetness, *rabri* is said to be one of the most delicious of milk preparations.

1160. *Dahi* : *Dahi* is one of the most important of milk products. If *ghee* consumes 57 per cent of the entire milk production, that production may be said to be mainly through the medium of *dahi*. In Madras 11 per cent of the milk goes to the market as *dahi*, apart from what is used for making *ghee*. Mysore tops the list with its consumption of 19 per cent produced milk as *dahi* ; next come Sind and Kashmir with their 14 per cent. The Punjab has little taste for it, utilising as it does only 1·1 per cent, while its neighbour the North-West Frontier Province consumes as much as 10 per cent.

The easiest way of preserving milk is to allow it to be fermented or soured into *dahi*. It may be kept for some days, although by keeping, its acidity goes on increasing. But beyond that, it remains as wholesome a food as at the start.

Much skill is bestowed on the manufacture of high class and tasteful *dahi*. The usual procedure is to heat the milk to boiling when all bacteria get killed. It is then cooled till luke-warm and the starter is added. The starter may be a speck from the previous lot. In setting milk for *dahi* a fresh earthen-ware vessel is used. The milk may be concentrated

by boiling in order to make the product more solid and rich. It may be sugared which will wholly mask any excess of acid development. The mass is allowed to rest while cooling and a coat of cream separates out on the top when the temperature has come down to the proper point. The starter is added without stirring the top surface. Just a little quantity suitable for the mass is let down. The temperature is allowed to be retained by surrounding the vessel with non-conducting cover after placing it on a non-conducting floor, say, of straw. *Dahi* may be made ready in 6 hours in the hot weather. By the regulation of the quantity of the starter *dahi*, the formation may be retarded at will to two days or more. By this device the *gowalas* get time to cope with unusual occasional orders at seasons of festivities by beginning milk collection and formation early.

Good *dahi* should present a clean, smooth, solid, uniform surface, free from water and without gas bubbles. The cut surface should be trim and free from holes. The formation of gas is evidence of the progress of injurious fermentation in the mass. Sometimes alcoholic fermentation occurs, giving a sharp taste to it. This happens with careless handling or from the use of bad and contaminated starters. The bacilli concerned is *lacto-bacillus acidophilus*. These are friendly bacilli and can live in the intestines. By remaining in the intestines these bacilli create a health-promoting condition there and prevent the growth of injurious bacteria. Many virtues are claimed for the lactic bacilli in the intestines.

Bacterial flora in the intestine of the infant is almost exclusively of lacto-bacillus. *Dahi* is claimed to give longevity and prevent disease. It is believed to cause better energy-utilization by man. Instead of taking plain milk in a fluid form, there is greater benefit in taking *dahi*, or *lassi* which is the same as *dahi* devoid of its fat. Skimmed milk also produces it, apparently as good as that made from whole-milk, though it lacks the wholesome and full taste of the fat in whole-milk *dahi*. *Dahi* from skimmed milk, beaten up and diluted with water, is indistinguishable from *lassi*.

When milk is allowed to ferment without the addition of a starter, but spontaneously from the bacteria from the ground or from the atmosphere, the result may be a substance which is not *dahi*. In any event, a very inferior article, the product of the action of many opposing ferments, would result.

The market quality of *dahi* depends largely on the starter. Investigations are being carried on in the Dairy Research Institute to isolate the better strains of *dahi* ferments so that by their use under specific conditions, a definite and standard product may be obtained. Nothing tangible seems to have been achieved so far. The real beginning for research in this line should be made by mastering the art of the renowned *dahi* makers. A scientist who can make *dahi* equal to the best *bazar* product by the current method may then proceed to analyse and synthesise conditions for the production of the best *dahi* under variable circumstances of season and weather. This should

be the objective before the research workers. The two classes of bacteria—the acid-producing and the aroma-producing ones—have to be separately cultured and their proper combination found out. In this way what is today confined to the skill of some expert practical men in every locality, may be made available to the public for the production of better class *dahi*.

Propagation is a great factor in these bacterial cultures. The bacteria from commercial samples under expert handling may be made to propagate indefinitely without losing character. There is a great field of research in this direction.

1161. Chhana : When milk is acidified with sour whey or with citric acid or lemon juice or alum, the casein substances separate out as precipitate, encasing within the casein all the fat-globules. So, by this one operation both casein and fat separate out from the milk. The fluid left over is whey which contains lactose and some mineral salts. In the production of cheese by the addition of animal or vegetable rennet the same phenomenon appears. But there is a great difference in their physical character. The precipitate from the addition of rennet is a very heavy, thick-set mass. This character makes the making of cheese possible. The precipitate obtained by acidification of warm milk is a light flocculent material and is particularly fit for the purpose for which it is utilised afterwards in making sweetmeats.

Chhana can be made from skimmed milk. But it will lack the feel and character of the whole-milk product.

The precipitate in *chhana* is hung from a piece of cloth and the water is allowed to drain out. The final draining out is done by placing the bundled material in the cloth in between two large wooden discs and pressing the water out by putting convenient weights over the top wood disc. A steady pressure gradually drives out the water from its interstices.

What is sold in the market is a product containing much water. Indeed, the practice in the marts for it is to weigh it just after taking the cloth bundle out of the separated fluid.

Chhana is made from boiling milk. It is brought to boil, and when so doing the acid liquor is added evenly over the surface. This is stirred, and again some more is added, till the end point is reached, when suddenly it separates out. The material is strained off through cloth, and is collected in a lump. The right quantity of acid and the right manipulation give the desired texture to it.

The acid liquid used for separation is best obtained from old whey which had been fully soured by keeping. This is a cost-less material and is eminently suitable for use for separation.

1162. Sandesh : After water has been drained away, the dry, compact *chhana* becomes suitable for the next processes in the manufacture of sweets. In Bengal, it is used for the manufacture of *sandesh* and *rosogolla* etc., and a variety of other sweetmeats. *Sandesh* is a dry product, obtained by incorporation of sugar with *chhana*, while *rosogolla* is a wet product

obtained by cooking balls of *chhana* in a medium of syrup and stored in the syrup.

For either of these purposes the preliminary step is to drain out all water from it and get it in a hard condition. When hardened it is placed on an wooden board and rubbed and manipulated to break it up into fine granules. For making *sandesh* sugar is incorporated at this stage by rubbing it in. There is much expenditure of energy in getting the *chhana* attain the texture suitable for cooking. When all the necessary sugar is added and the mass brought into a condition of fine division, it is placed in a large *karai* over a fire. The mass is now stirred about to be uniformly heated. Heat and moisture dissolve the sugar crystals which are enveloped in the *chhana* till the whole becomes a homogeneous mass and loses water, imparting just a little stickiness to the mass to make it sufficiently plastic to be moulded into balls or put in moulds. After this the balls or shapes cool and get hardened. Cardamoms and other spices are incorporated in a finely powdered state during the last stage of working up the mass in cooking. These give the special flavours. There are varieties of flavours to choose from.

Sandesh, thus made, may remain three days without becoming stale. In the hot weather it does not keep so long. The more solid and dry the mass the better becomes its keeping quality.

For *rosgolla*, *chhana* requires manipulation and aeration. In the aerated condition the mass is made into balls and put into a boiling syrup of proper

consistency. Heat expands the encased air globules and subsequently the syrup goes to fill up the vacuoles. The ball is a more or less spongy mass soaked to the full in syrup.

The manufacture of both *sandesh* and *rosgolla* requires skill, and a knowledge of their peculiar technics which can be learnt by working with manufacturers. There is no secret about these manufactures. Different manufacturers impress their peculiarity upon their products, which it is not possible for a novice to copy. The ordinary method of manufacture is, however, easy to learn.

These two, *sandesh* and *rosgolla* are only typical of the uses to which *channa* is put in Indian confectionary.

1163. Condensed milk : Tinned condensed milk is either whole milk or skimmed milk evaporated down under vacuum and sweetened or left unsweetened. The product is tinned and packed in cases, and sold. It is a Western product and is likely to remain so in the existing condition of India. The trade in these imported articles is not large, and if people take proper care of the Indian resources for meeting their needs of milk, these canned milk products may not be needed except in trifling quantities.

The reason is not far to seek. This condensed milk industry on examination is found to be really a canister-making and sugar-selling industry. The part that milk plays in it is minor, being only of the nature of a filler.

For marketing a maund of whole milk worth Rs. 5/-, the manufacturer would have to sell about Rs. 20/- worth of condensed milk. Similarly, for marketing about 12 annas worth of skimmed milk the manufacturer will have to sell Rs. 10/- worth of skimmed condensed milk, even at competitive prices. The rest of the value of the tinned milk will go to the tinplate industry, and to the tin canister maker and packing case maker, and for sugar. So, it is really a canister maker's industry and not a milk dealer's or milk producer's. From the above point of view any one contemplating the establishment of this industry should ascertain the canister-making possibilities first.

According to Wright, for handling skimmed milk as condensed milk, the manufacturer will have to turn over Rs. 28/- worth of goods against Rs. 3/8/- worth of milk. From all points of view, the proposition is one for the tin-can makers. Wright also says that the quantities of milk required for running a factory is excessively large, being 30,000 lbs. per day. He supposes that there is no possibility of obtaining so much milk from villages round about a factory. Therefore, it may be said that there is little possibility of working a modern condensed milk plant in India, at least in the near future.

India has been importing about 25 lakh rupees worth of condensed and dried milk. The trade in dried milk is increasing at the expense of condensed milk. For the present all that can be done to stop this import (principally of tins and fuel and sugar

and packing case) is to seek for a cottage source for the article.

Condensed milk of the grade equal to the grade of the imported product can be successfully made in cottages if the problem of canning is simplified. If kerosine tin canisters are used for storing condensed milk, then the industry can be started in villages for feeding the village population during off-seasons or for feeding the nearest marts. The package in kerosine tins becomes cheap. The only consideration would be that purchasers would have to use up such a tin of sugared concentrated milk in course of a week.

The milk need not be necessarily evaporated under vacuum to be brought to the concentration ratio of 1:2.5, so that it may re-dissolve and form re-constituted milk. It can be heated over direct fire up to a certain concentration and then transferred to a water-bath for finishing when the requisite quantity of sugar is also added.

1164. Condensing milk—a cottage process : Five pounds of milk is evaporated in a clean, tinned brass vessel or an aluminium pan till it is reduced to half its bulk. During heating the milk is not allowed to boil briskly. This can be accomplished by constantly stirring the milk on a moderate fire.

When the milk is reduced to half its bulk, add one pound of sugar and heat the pan over a water bath. The water bath can be made by choosing a vessel which is of somewhat smaller diameter than the pan. Water is put in the outer vessel and the pan

with milk is put over it. Boiling water heats the milk in the pan which evaporates it. The milk should be stirred all the time. When the milk with sugar weighs half the weight of the original weight of the milk, then the process is completed. In order to accomplish concentration to accuracy, the empty milk pan is to be weighed. If now, after the concentration, the vessel is re-weighed then the weight of the concentrated sugared milk is found out. If the vessel weighs more than what is necessary, the concentration is to be carried on a little further and again weighed. After a few trials it will be easy to know the completion point from the bulk of the concentrated milk.

CANNING: It is no less important a process than concentration. It may be regarded as a more important and delicate process. Tin containers are first of all cleaned with water and dried. In the dried can is poured the hot concentrated milk. The top of the tin has a small opening through which the milk is filled. After the filling, the opening is sealed. Then a pin-hole is made on the lid and the cans are arranged on trays of water, reaching nearly half the height of the can. The tray is heated and the water kept boiling for half an hour. Then the pin hole is closed by a drop of solder. This finishes sealing.

The closing of the lid of the milk can should be done without moving the vessel. The filling should be done with a funnel and the manipulation is to be so clean that no milk may come in contact with the

under-surface of the top. Should there be any milk adhering to it then the heating for soldering the opening will char the milk, giving a smell of burnt milk to the contents of the can.

1165. Milk-contents of infant foods : Milk products in the form of infant foods are imported into India to the value of 23 lakhs of rupees. When the matter is enquired into, it will be found how dearly the country is paying for a nominal quantity of milk !

The average scheduled price for infant foods is Rs. 1/13/- per pound. How much milk does a pound of milk food or malted milk represent ? Horlicks Milk food contains 2·2 lbs. of milk per pound of bottled food. The purchaser of a pound bottle of this milk pays Rs. 1/13/- for one seer of milk. There is a little malt and a little starch in the digested or malted condition. Can India continue to send out 23 lakhs of rupees for such stuff ? And is it necessary for the poor people of India to buy milk at such fabulous prices ? Advertisement is a great thing in the modern trade world. Few doctors care to know how much real milk they are prescribing for their patients when they recommend these infant-foods, and how many mothers care to know what quantity of real milk they are feeding to their sick or weak children from a pound of malted milk ! If they knew they would think of something else in place of these much-advertised and costly foods. These foods are suitable for babies and invalids of rich countries, not of India.

The reputed malted milk foods for infants contain essentially the following ingredients :

For one-pound bottle.

- (i) A quantity of the extract of germinating barley.
- (ii) A quantity of starch.
- (iii) One seer of milk.

(1) If a quantity, say, $\frac{1}{2}$ seer of barley or wheat, is germinated, the enzyme malt is formed. If this is crushed with water, a mash is formed which contains all the active enzymes. This can be very easily home-made.

(2) A quantity of starch. If arrowroot or wheat flour is boiled with water and made into a gruel, the starch is obtained in a thin form, ready for being reacted upon by malt and converted into a soluble malted product. Flour gruel can be mixed with a quantity of the malt-extract of No. 1, at tepid heat and kept for an hour or so at that temperature to end the reaction.

(3) A seer of whole milk added to the mixture of 1 and 2 will complete the malted milk food in a fluid condition ready for use and will represent the content of a pound bottle. One pound of malted milk food need not be made at once. Supposing that one-fourth pound of food is used daily for an infant or invalid, then only about $\frac{1}{2}$ lb. or $\frac{1}{4}$ seer of raw milk is being given. A poor quantity. This little milk may be mixed with some arrowroot gruel. You get the basis of the malted milk. To this add some mash from freshly-germinated wheat, pounded and made into a paste with

water and then filtered through cloth. The extract is malt-extract, to be mixed with the gruel and milk mixture in tepid condition, to represent the one-fourth pound of malted milk, costing about seven annas. You replace the factory product by a fresh article at a cost approaching one anna or less. And if you were using not quite as much as one-fourth pound a day, if you were using 1 lb. of milk per week, you had been consuming what you can produce at a cost of half anna per day. The only point about the replacement is the matter of making a little fresh malt extract. How easily it can be made will be apparent from the following description.

1166. Malt extract for infant-food: Take a quantity of grain, say, paddy or barley. Clean it thoroughly free from dust and other foreign matters in a dry state. Wash it in water till only clear water is obtained in the washings, keep the mass under water for a day and night. Next day drain off the water and put the soaked grains in a piece of cloth and loosely tie up the grains in a bundle and hang it up in a dark place. In another 24 hours the seeds will germinate. The germinated whole grains are pounded or mashed thoroughly on stone with some water. The mass is passed through cloth and the clear liquid taken as malt extract. This fluid contains the digestive enzyme or malt and is to be added to the gruel and milk for pre-digestion.

1167. Cheese: About 8½ lakh rupees worth of cheese is imported every year into India. An equal amount worth of butter also is imported. Cheese and

butter are milk products for people in the West. In these countries people principally use milk in its raw form. And when they go in for milk-products they take butter or cheese. In India we have varieties of milk products including butter also. But butter as a village product of the *gowala* is a different article from the imported or factory-made tinned product.

As for cheese, the taste for this article has not yet developed in India, and India has not the suitable climate for the manufacture of really good cheese. So those who must have cheese of European quality will have to depend on imports or be satisfied with the substitute product which can be made in India under ordinary conditions.

The 10,000 cwts. of cheese imported into India costing 8½ lakh rupees is mostly consumed by Europeans. The difficulties in making cheese in India for them are enumerated below.

1168. Manufacture of cheese : Cheese in the primary stage is like our *chhana*. Milk is taken and allowed to coagulate with the help of rennet. This is done just as *chhana* is made from whole-milk. In case of the former the milk is brought to boil. For cheese this is not done. *Chhana* is a precipitate, whereas cheese is a coagulum.

Rennet is an enzyme. It is of animal origin. The young of bovine or ovine animals have rennet in their fourth stomach. It is designed to coagulate the milk which the calves and kids suck from their dams. Milk on entry at the fourth stomach gets coagulated into a compact mass. The calves and kids need it

in that condition for better facility of digestion. If a calf is slaughtered, and its fourth stomach scraped out, rennet is obtained. This can be dried and preserved. Just a little of it will coagulate a large quantity of milk. The special character of coagulation is that the mass gets solid in a very short time, a few seconds being required, and not like *dahi* which takes hours to coagulate.

For the manufacture of cheese, milk is treated with rennin and the coagulum allowed to drain off from wicker baskets. The contents of the baskets are left in that condition for the coagulum to harden. The outside is smoothed and stored for maturing. When mature, cheese develops a special flavour which is liked, and some changes occur within the body, making it tasteful.

The difficulty in India is about rennet. There is an aversion to the use of this slaughtered animal product. There are men who secure rennet and make cheese in India.

Recently a vegetable substitute of rennet has been exploited. The berries of *withania coagulans* contain rennin. These berries may be extracted with salt water and the extract used in place of animal rennin. One gram of berries gives enough rennet for coagulation of 100 grams of milk. This plant is common in the N. W. F. P., the Punjab and Sind. So far, this rennet has been found to be equal to the animal product. The milk is to be heated to about 155 to 160°F. for the best results. The time taken for coagulation is about 30 seconds.

DIFFICULTIES OF CHEESE MANUFACTURE: Cheese requires high humidity and a comparatively low temperature for its ripening. The temperature is 55 to 60° F. High temperature induces putrefaction and the drying becomes excessive. It makes the article more liable to the attack of vermins and insects.

For these reasons ripening which develops the special quality of cheese cannot be done in India except under artificial conditions of temperature and humidity. Such artificial arrangements will increase the cost inordinately.

What is made in India up to now is not really cheese, but as Dr. Davies called them, they are curd-cheese. Their flavour is also that of acid curd or smoked curd. The mellowing that comes to cheese due to protein break-down during ripening is absent. There is really no ripening of cheese in the products made in India.

Cheese is made in India, though in very small quantities in Surat, in Dacca and in Bandel. Dacca cheese is a smoked product. After draining the clot by pressure, the soft cheese is taken out and allowed to dry for a few days. Thus a thin hard outer crust is formed. The cheese is then smoked with wood smoke or cow-dung smoke. Smoked cheese keeps for one to two months.

Surat cheese is like Dacca cheese, but there is a difference. The former after the draining and pressing out of water, is placed in acid whey containing salt. This operation hardens and brines the cheese.

A hard coat is formed on the outside. This cheese is not smoked and must be consumed in 10 to 14 days. It may be made by simply draining the skim-milk *dahi* and pressing the solid matter by keeping it hanging. This may then be salted and cast into moulds and preserved. Such preserved cheese ought to be popular so that a nutritious protein food in the form of skim-milk may not be wasted by conversion into casein.

1169. Butter : Village butter in the state in which it is made for making *ghee* contains much casein and water. This material may be made like butter of the West by subsequent treatment and beating. The difficulty with butter is to give it a keeping quality. Butter, as good as the imported article, is now being manufactured in India from cream. In

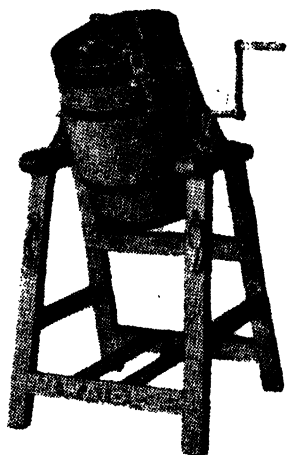


Fig. 52. Butter Churn.

appearance and taste the tinned products are quite up to the mark. About 9 lakh rupees worth of butter is imported. With the development of the Indian industry, imports may diminish.

Butter can be made from fresh cream, or it can be made from crude butter obtained by churning *dahi* used for the manufacture of *ghee*. The difficulty is

that once the cream or the hand-churned mass from *dahi* get some undesirable flavour, it is not possible to make good butter from it having the standard flavour.

A method is described below for making good butter from cream. Cream, as obtained from home-separated cream, is in an acid condition. In order to determine the acidity of cream the same method is to be used as is described later on under *Testing for Acidity*. If the cream developed any acidity it

may be brought down by the addition of a quantity of soda bicarb solution. The acidity should be brought down to, say, 2.5 per cent.

One pound of soda bicarb will reduce the acidity of 100 lbs. of cream by 1 per cent. Upon

this basis a definite quantity of soda bicarb should be added to the cream. Excess of soda bicarb will make the taste of the butter bitter. Care should be taken to see that excess of soda bicarb is not added. Addition of soda bicarb creates difficulty in the process of churning by formation of gas.

The cream is churned in a churner. A barrel churn has been described. It is one of the best churns.

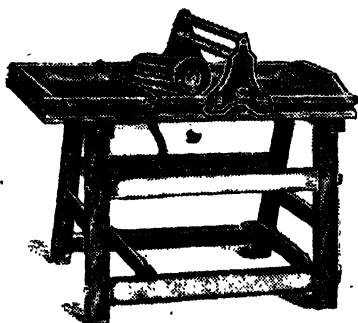


Fig. 53. Butter Worker.

1170. **Temperature of churning butter :** Cream should be brought down to 45°F. before putting it in the churn when it is revolved at a rate of about 40 turns per minute. A little less than half the drum should be filled with cream. If the quantity is less, the drum should be turned at a lower speed. The completion of churning is reached when grains of butter of the size of a wheat grain appear. This stage should be attained by churning for half an hour. Temperature is a factor involved in the determination of the finishing of churning. About 60°F. is the best temperature, which is much lower than the atmospheric temperature in summer. In winter the temperature of 60° or about is normal in many places. In summer the cream should be cooled by keeping it in a vessel surrounded by ice water to obtain the best effect, so that the temperature of the cream comes about that. The churn should also be brought down to this temperature by allowing some ice cold water to be splashed on it for some time. Good butter is a natural product of countries having cold climate. If, in India, we want to manufacture really good butter, artificial cooling will have to be resorted to in the plains except during the winter season.

The time for churning is fixed at 30 to 35 minutes. If the churn is not completed, as evidenced by the non-appearance of the proper size of fat-granules, then the temperature should be so regulated as to bring the finishing time within the limit of about half an hour. Too early finishing and too late finishing are both to be

avoided. The appearance of wheat-grain-sized granules is called breaking.

On starting to churn, after the introduction of cream at the proper temperature in a churn of the same temperature, a few turns are to be given. The churn should be stopped and the plug taken out. This allows a lot of gas which was held in the cream to escape. After a few moments the plug is replaced and churning continued at the proper rate of rotation for about 30 minutes. There is a peculiar splashing sound when the cream is broken. Some experience will be able to guide the proper working so that the breaking of cream takes place at the correct time by allowing correct temperature and corresponding speed of rotation.

Stop the churn at this stage and allow some cold water in. This helps the separation of butter-milk and prevents too much of it getting into the butter. This wash water should be 5 or 6 degrees below the temperature of the mass, 50 to 60° F. inside. If the water is too warm or too cold, it will spoil the texture of the butter, and in both cases make the butter incorporate too high a percentage of water.

Turn the churn for 5 minutes and allow the butter-milk to run off through a sieve which will collect any butter-grain carried out. Most of the granules will be left over in the churn as lumps of fat. Only loose particles will drain out. These are to be caught in the sieve and returned to the churn.

1171. Washing churned butter: After the draining off of butter-milk an equal quantity of cold

water is to be poured in. Give the handle a few turns and draw off the wash-water at once. If the butter is too soft, pour some more well-cooled water and give a few turns for washing. The washing should be limited. Too much washing spoils the flavour and character of the butter. After water has been drained out, introduce some salt dissolved in water. Salt may be to the extent of 2 per cent of the fat. Some add dry powdered salt while "working" the butter in pressing out the water. But there is a risk of salt grains remaining intact in the mass of butter which may cause a clotted appearance, for in places of contact with salt the butter assumes a deeper yellow appearance. The salted butter is emptied out of the churn and "worked" for pressing out water and any adhering butter-milk.

Everything that comes in contact with cream, once it is put into the wooden churn, should be made of wood. Metal is inadmissible. Butter is pressed out and re-pressed in the "worker" till all excess water is pressed out. The legal limit of water in the fat is 16 per cent. It should be seen that no more water than what is allowed by law remains in the butter. The finished butter is then ready for filling in tins for marketing or for selling loose. It should be stored in cool cellars, preferably at low temperature.

There was a belief current that the addition of salt adds to the keeping quality of butter. It has, however, been found by investigation that non-salted butter keeps the flavour better under the same conditions of storage.

1172. Cleaning the churn : The churn should be washed out after working, with slightly warm water to get rid of any remnants of fat adhering to the wood. Then it should be scoured in and out with boiling water which will kill all bacteria. Finally, it has to be rinsed once again with boiling water and allowed to dry in the sun. Sunning inside and outside keeps the churn sweet and does not let any mouldy odour to develop that may spoil the future lots. All utensils and appliances employed should be scalded and cleaned and sunned with the same care, including the "worker". The churn may be finally washed with salt water to keep the machine sweet.

1173. Separated milk : Separated milk has no legal status in certain provinces, while it is recognised as a legitimate dairy-product in others.

Enough has been said to prove the high place which skimmed milk ought to hold in our dietary. There is a great deal of ignorance prevalent about it. It has been found in the case of school children as also in the case of calves that skimmed milk is a great growth-inducing factor. The real difference between whole-milk and skimmed milk is on account of the fat which the one contains and the other is denuded of. So far as skimmed milk and cow-butter-fat are concerned one would be inclined to evaluate the two products equally. The skimmed milk retains all the complete proteins of milk, it contains all the sugar and what is more, the mineral salts, so necessary for maintaining health and growth. These nutritional factors should be widely appreciated, and

skimmed milk and *lassi* should be prized and given the full nutritional value which they deserve. Not only are the ignorance and prejudices of people to be removed, but Governments should be induced to recognise its importance and take adequate steps to promote its use and conserve it for human consumption instead of allowing it to run to waste from the creameries, where this is done.

During the war or in abnormal trade conditions, casein from the skimmed milk of creameries fetches a value which may make it worth while to manufacture it. In normal times when casein is imported cheap, it is hardly worth while to recover it from skimmed milk and

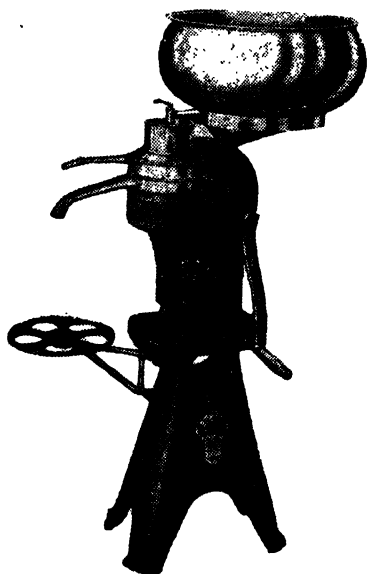


Fig. 54. Cream Separator.
(See page 1076-'77)

separate, dry and powder it for marketing as casein. The direction in which the public and the Provincial Governments should move is to impress upon the food value of skimmed milk and provide for its use as food.

Skimmed milk may be coagulated by vegetable rennet and the solid curd obtained may be first brined

like Surat cheese and then smoked like Dacca cheese, (1168) giving it a life for three months or about. Taste is an acquired matter. The taste of cheese made without contamination with animal rennet should be acceptable to all. Such fat-free cheese may be cooked with curry and eaten or made into other culinary products. The very valuable proteins that milk has, can on no account be allowed to be wasted or used for industrial purposes in India. If there are localities where men will not be educated to its use, then let it be sent out to those provinces where the taste has been acquired. Immediate use of skimmed milk may be made in calf-feeding.

1174. Fat-free chhana or casein: What has been mentioned about the manufacture of cheese from separated milk should apply to casein also. Where casein is made, it should be made in a sufficiently clean way to serve as human food. The material is the same, call it casein or call it fat-free *chhana*.

Casein is made a little differently from cheese or *chhana*. This industrial product, when not made for human consumption as suggested above, but meant for industrial use only, should be entirely fat-free. For this purpose, skimmed milk should be passed over and over again through the separator to take off the last traces of fat. The milk is then curdled by the addition of *dahi* starter. After the *dahi* has set it is taken out and allowed to drain through cloth. The drained mass is fat-free *chhana*. Very large quantities of it, made from skimmed milk by precipitation with acid whey, is used daily by confectioners in

Calcutta where it is brought in from distant *mofussil* stations. This importation of fat-free *chhana* to Calcutta is allowed to go on from day to day despite the legal bar, being against the Food Act of the Bengal Government. The trade in *chhana* is there, but the prices fetched are most precarious. Often the supply just fetches the railway freight. On other occasions, a price of ten to eight annas per maund of skimmed milk may be realised.

To come to the industrial aspect of it. Fat-free skimmed milk, made into *dahi*, is separated and allowed to drain off under pressure of weights. It is then passed through wire mesh to give it a granular character and then dried in the sun. This makes the casein of commerce.

CHAPTER XXVI

COMMERCIAL MILK AND ITS ADULTERATION

1175. **Commercial milk and its adulteration :** The handling of milk under the existing conditions is not satisfactory. Much can be done to improve the cleanliness of milk from the udder to the market. The fact that it is universally boiled before use counteracts much of the negligence in handling. Heating may prevent disease. But unclean handling should be avoided. In fact, in many instances sanitary habits have got to be inculcated. In *bazars*, even at Calcutta, one may see a purchaser dipping his finger into the milk in bulk, to examine its quality, and that finger may have been contaminated with anything. We have come to tolerate this sort of insanitary habits. In the interest of better living such crude and insanitary habits should go. We do not allow any body to dip his finger in our drinking water, even if that water is to be boiled afterwards before use. We try to keep food materials clean and free from contamination in our homes. But milk brought to the *bazars* in some places gets to be treated as if it was not a material. That we boil it is good. But the handling should be such that it could be used even without boiling. With this ideal before us, the prevalent malpractices about handling milk ought to be changed.

There are, however, points in which an excessive emphasis might be put on this matter out of an imitative tendency for the methods suitable in European countries. An instance may be given about the milking pail. Current literature in India is full of descriptions of the dirty way in which milk is received in pails. Dr. Wright observed this tendency and this matter in the proper perspective.

"...Conditions in India differ fundamentally from those in temperate climates. The cultivator is poorer and is, therefore, usually unable to purchase special dairying equipment. The average temperature is very much higher, though the intense sun-light is credited with a strong sterilising power. Fuel is scarce and water for cooling is seldom available, or if available, effective. It is, indeed, obvious that under such circumstances methods of producing and handling milk may have to be greatly modified from those employed in countries situated in the temperate zones. A technique suitable for tropical and sub-tropical conditions must be devised to meet these special difficulties."

"It would, perhaps, be desirable to give a concrete example of the point which I desire to emphasise. At several villages during my tour I had opportunities of seeing the methods adopted in cleaning vessels used for milk. This usually consisted of scouring the vessel with a mixture of earth and wood ashes, which was subsequently rinsed out with well-water and then stood in the sun. This method was usually pointed out to me as an

example of the dirty methods employed by the cultivator. It is, however, quite likely that the results are, in practice, far more satisfactory than one might suppose. In the absence of soda and refined abrasives (which form the basis of ordinary scouring powders) a mixture of earth and potash (ashes) would form a cheap but efficient cleaning mixture, while the lethal action of the sun-light might possibly be found to destroy any contaminating organisms.... But the point is that even a simple matter such as this has not been investigated, so that no reliable guidance can be given to the cultivator as to the directions in which his methods are sound and the lines along which they might be further improved." (*Wright's Report. P. 19*)

Not only has no investigation been conducted on the advisability of continuing the prevalent practice, but a wrong lead is often given, when for example, a half-covered can is held up as an ideal thing for milking because the half covered top prevents the falling in of dirt from the sky or ceiling. It is forgotten that a flat-bottomed vessel is no superior substitute to the round-bottomed Indian ware. Flat-bottom has crease which lodges dirt. It is also forgotten that the half-covered top will hide inside dirt or dirt on the under-surface of the cover which it will be difficult to clean and inspect.

The round bottom milk pail, held slanting between the knees, is one of the best arrangements for milking. The slanting mouth keeps off falling dust to an extent while the bottom is sanitary.

We have to look at things with Wright's eyes and Wright's sympathy before we start a condemning and ridiculing campaign. The book "Report on the Marketing of Milk" is an instance in point. Photographs are given of the dirty ways. The photographs and the remarks on them are painfully unsympathetic, superficial and taunting, specially as they throw little constructive light on improvements about conditions and collection, transport and marketing of milk. Improvements have to be made, but a proper, sympathetic and practicable guidance has to be given.

We have copied some Western faults, or faults of modernisation, and these have to be discarded. Milk is delivered now-a-days in cans with a tap at the bottom. It is an innovation. The flat-bottom has replaced the old round-bottom and a tap has been added which can never be cleaned properly, however bright the outside may be polished. These are due to ignorance, bad lead and thoughtlessness.

1176. Adulteration of milk: The fault of intentional adulteration of milk with water is a very serious one. Adulteration was not practised to such a large extent before. This habit is gaining in strength, affecting our whole social and economic life. Money has become the only objective and money has to be acquired and, therefore, profit has to be made by any means. If one bad trader adulterates and makes illegal profit or lowers price by adulteration, at once a race is set up. Another man proceeds to adulterate more and make the commodity cheaper to have yet more customers. The race continues, dragging more men

into the pool. It may be that the present times are so. If that be the case, the times have to be changed, and we have to go back to the purer days of old. The present practice is of "catch if you can". Adulteration is to go on. Catch, bring within the clutches of law and punish if you can. Methods of evading the law will be devised. Catch again and punish if you can. This is the ever-increasing vicious circle. It speaks of the present times that well-intentioned men, desiring to stop adulteration, are found in the end to advocate toleration of adulteration, because by the selling of adulterated milk poor people can be served with cheap milk. This argument is repeatedly come across deliberations of Government officers and public bodies. Suppose the poor man was served with pure but costly milk, and was asked to adulterate it himself? The poor consumer will find it certainly cheaper to mix water himself than buy at cheap rate a watered product of uncertain milk-content.

The idea of honest dealing in milk is disappearing. The greatest amount of adulteration of milk takes place in the places of largest demand, the towns and cities. The corrupt practice of adding water to milk is not confined to towns. Unless the supplier is a person or a firm of known honesty, or unless the animal is milked in the presence of the customer, the presumption would be that the milk may be adulterated, so wide is the prevalence of adulteration. Some of the reputed farms also are found to indulge in the practice of adulterating milk and passing diluted buffalo-milk as cow-milk. In a city like

Calcutta, in which there are thousands of she-buffaloes kept for milk, there is hardly any shop where buffalo-milk is obtainable. All the milk produced passes under the name of cow-milk after adulteration with water.

Under such circumstances, even a higher price is ordinarily no guarantee that the milk is pure. A reverse tide is set going out of this mentality, and it is reasoned that if milk cannot be had pure and when there must be adulteration, then the cheaper milk should be purchased which cause less loss in the purchase of milk. Sometimes this proves to be correct, though it cannot be always so.

1177. Milk samples : examination results : Below is given a Table showing the percentage of adulteration in the samples examined.

TABLE—121.

*Samples of milk examined under the Food
Adulteration Act.*

Province.	Total No. examined.	Per cent found adulterated.
N. W. F. P. ...	70	29·0
Punjab ...	1,505	30·1
Delhi Province. ...	2,993	17·2
Sind ...	1,006	28·6
Bombay Province. ...	9,088	22·0
Madras Province. ...	3,834	49·0
Central Province. ...	629	30·8
United Province. ...	2,472	19·8
Bihar and Orissa. ...	139	59·7
Bengal ...	2,086	52·8
Assam ...	96	91·9

Total—23,918 29·7

—(*Milk Marketing Report, 1941-42. P. 229*)

The Table does not give a correct idea of the extent of adulteration. The test is made according to the standard set for the milk in the province concerned. If the standard is initially low then those samples that fall within the standard limit may also be found to be adulterated.

● **MILK STANDARD AND LEGISLATION :**
Three classes of milk are generally recognised—cow-milk, buffalo-milk and mixed milk. But this division is not operative everywhere. Very generally, milk is regarded as cow-milk, and a standard for cow-milk only is officially recognised in most provinces. Even in the matter of standard, the variation from province to province is great. The following fat-percentages in milk are prescribed by the different Provincial Governments.

“...Madras and Central Provinces have a standard of 3 per cent fat for cow's milk, and Madras 4·5 per cent and the Punjab, U. P., N.W.F.P., and C. P., 5·0 per cent fat for buffalo-milk, and Bihar 5·0 per cent fat for mixed milk. The N. W. F. P. has a minimum standard of 8·0 per cent s.n.f. for cow's milk, a standard which is, perhaps, too low; the C.P. Government has a minimum standard of 8·5 per cent s.n.f. for buffalo-milk. ...”—(Davies.—*Indigenous Milk Products of India*. P. 18).

In the light of the above it will be easy to see that where a fat per cent of 3 is prescribed for the cow, more adulterated milk will pass off as genuine than in a province where, for example, the standard, as in Bengal, is 3·5 per cent.

If milk containing 3 or 3·5 per cent fat content is passed as genuine against 4·5 per cent fat actually present in cow-milk, then these samples that are passed as genuine will fall very short under the real standard of 4·5. The percentage of adulterated sample in the Table will enormously increase.

The milk standard has been set very low in India. It is difficult to say why this low standard was accepted initially and is still persisted in, when, as a matter of fact, it is established and widely known that the Indian cows give 4·5 per cent fat in the minimum when bulked samples from several cows are tested.

One reason for the acceptance of the low standard of fat is that the regulations for standard were made by copying out from the regulations of other countries where cow-milk show 3·0 to 3·5 per cent fat without any reference to the realities. This legalization of 3 to 3·5 per cent fat has encouraged adulteration at least in the Municipal areas. In Madras, for example, a man selling genuine cow-milk with 4·5 per cent fat will obtain the same market price for milk as another man who dilutes his milk with 50 per cent water and makes 45 lbs. toned-down standard milk from 30 pounds genuine milk. The adulterating dealer thus will get a premium of 50 per cent. The result is that milk dealers will be led to water down all genuine milk at Madras with 50 per cent water. And such 50 per cent adulterated milk will pass off as genuine milk after analytical examination. When the sample will show less than 3 per cent fat, then only will the deficit be regarded

as a measure of adulteration, and the sample will be condemned as adulterated. In reading the Table, showing percentages of samples found adulterated, the above circumstance should be borne in mind. The reader will then have an idea of the extent of adulteration where a primary adulteration with 50 per cent water is excused. Adulteration, it will be apparent, has been fostered directly by the Municipal standards fixed where such standard for cow-milk is lower than 4·5 per cent.

Then again, the fiction of allowing a mixed milk standard has given another incentive to adulteration. When the fat percentages are so different as in cow-milk, the mere statement "mixed milk" is not enough ; how much of what milk are there should be made clear. Again, why should there be mixed milk at all ? When we know that the two milks are different in their contents and in the structure of their fat-globules, it is imperative that mixed milk should be a prohibited commodity and legal protection should not be given to those who pass off buffalo-milk diluted with water as genuine cow-milk. An examination under the microscope ought to reveal whether the sample is really of cow-milk or a mixture of water and buffalo-milk.

1178. Foreign practice guides milk legislation : The Report of the Marketing of Milk brings out how absurd rules have been copied out and, though impracticable, have found their way into Provincial enactments or regulations on food adulteration. The *halwais* of the Punjab are required, for example, to keep their floors, tables, shelves and all other articles

washed every day. Or, for example, the milk dealers of the United Provinces are required not to sell or permit to be sold the milk of any animal suffering from any contagious disease (including tuberculosis of the udder). Even in England milk from tested tuberculosis-free cow is marketed separately under a guarantee, and the cows of the herd are officially tested. Here in the U. P. without any provision for the testing of cows, a regulation blindly finds a place in the statute book.

Just as there is no fixed standard for liquid milk all over India, similarly in the case of milk-products also, there is no reasonable standard ; or meaningless standards have been given the sanction of the legislature. What Dr. Wright wrote in this connection is pertinent.

"The establishment of recognised standards of quality for *khoa* and related products would do much to encourage the introduction of improved methods of production and packing. At present the standards (where they exist) are of doubtful utility. For instance, under the Punjab Pure Food Act (1929) *khoa* must have not more than 10 per cent moisture and not less than 20 per cent fat. Yet, according to manufacturing practice, the *khoa* out-turn from milk should be 25 per cent. *...Clearly the existing standards need re-examination.

"...No provision is made in the food legislation of most provinces for standards of quality of milk products made partly or wholly from separated

* 25 per cent yield is of kheer and not khoa.

milk. ...it will be necessary to formulate standards not only for whole-milk products but for products manufactured from separated and from half-cream milk." (*Wright's Report*. P. 47-'8)

The situation in some cities, for example in Calcutta, is obnoxious to a degree. The Calcutta Corporation under its food regulations does not recognise skim-milk or skim-milk products. Skim-milk cannot be sold regularly in Calcutta. That it is sold in the name of pure milk, as a matter of fact, is a different matter. But legally there is a bar to its being sold under the correct description as skimmed-milk.

1179. Skim-milk and Food Acts : The Report on the Marketing of Milk mentions this difficulty about the Co-operative Milk Societies Union Limited of Calcutta which body is supposed to throw into the drains of Calcutta this nutritious material because the law prevents its sale. What the Society does, the Society only knows, but it is in print there in the Report.

Not only is skimmed milk barred from entry into the market, but the selling of skimmed-milk products as such is penalised. The penalisation is, of course, in name. As a matter of fact every day, morning and evening trains to the four railway stations of Calcutta bring loads and loads of skimmed-milk *chhana* as a matter of routine which find their way into the *chhana* mart of Bowbazar. There are arrangements by which this is openly done. The guardians of health have health officers and their subordinates. They have to show that they are dutiful,

and the public are also to have cheap *chhana*. As a matter of routine once in a month or oftener, if there is provocation from the whole-saler, the inspector goes after the carriers of *chhana*. The carriers also know the practice. They fly away helter skelter, and occasionally a man is caught and his load discharged in the gutter. Occasionally an *aratdar* (dealer) is prosecuted. He pays his fine and knows how to behave better with the inspector. Could this thing continue if the Health Department of the Corporation was serious about stopping the import of skimmed-milk *chhana* for sale in Calcutta? A foolish law enacted when the science of nutrition was not even in its embryo yet stands, and the above is an illustration of how it is operated.

The mischief does not stop here. A colour-distinction also is made. Skimmed-milk product in the form of condensed milk, or skimmed milk-powder, is imported and retailed out everywhere in the city of Calcutta without any bar. In Calcutta, skimmed milk must wear foreign clothes, must come in tins and get above the law.

While all this is happening in Calcutta, the Bombay Government has provided certain regulations regarding the total S. N. F. content of skimmed milk-powder and the India Government has exempted skimmed milk-powder from the import duty in order that it may be used largely for improving the health of school-going children. Cannot Calcutta children have skimmed milk *chhana* for their health, and the Calcutta public also?

1180. Harassing persecution : The persecution, only for harassment, extends to the interior also. If a *gowala* buys skimmed milk from a creamery and make *dahi* from it and sell it cheap as a skimmed milk-product, he becomes the subject of attention of the Sanitary Inspector. He has to pay a fine in the local court or, otherwise satisfy the Inspector to escape prosecution.

Things are too bad in the matter of Provincial Acts, and Municipal regulations about food adulteration and their operative portions are scandalously oppressive and inefficient.

1181. Breaches of Act lightly punished : In 1937 Dr. Wright pointed out how breaches of the Food Act were lightly dealt with in some cases. Things have not improved. The latest edition (1941-'42) of the Report of the Marketing of Milk has the following :

“A butter merchant of Mazagaon (Bombay) was fined for habitual offences under the Bombay Food Adulteration Act, 1925, as follows :

Rs. 5/- on 16th January, 1939.

Rs. 5/- on 16th January, 1939.

Rs. 15/- on 13th March, 1939.

Rs. 60/- on 21st August, 1939.

Rs. 100/- on 21st August, 1939.

Rs. 16/- on 12th February, 1940, for 12 per cent excess moisture in butter.

Rs. 50/- on 15th May, 1940, for 19 per cent adulteration in butter.

Rs. 10/- on 15th May, 1940, for 9 per cent excess moisture in butter.

"Several other instances of ridiculously low fines can be quoted. In one case, for butter which was adulterated to the extent of 74·1 per cent, an Honorary Magistrate fined the accused Re. 1/-. Fines on milk cases generally range from Rs. 2/- to Rs. 20/-..."—(P. 227-'28)

The Report pointed out that the Bombay Act provided for a fine of Rs. 200/- for the first offence and fine up to Rs. 1,000/- or imprisonment or both for subsequent offences.

The I. C. A. R. has been moving in many directions in order to give shape to the recommendations made in Dr. Wright's Report. But things move so slow. The position taken by the I. C. A. R. about *ghee*-adulteration has been mentioned earlier. The Central Government can give a lead. Not only that, it can by moral pressure impose its will upon the Provincial Governments in this vital matter, for it is the Central Fund coming through the I. C. A. R. which is responsible for much of the research work on Animal Husbandry and Agriculture that is being conducted in the provinces. The Provincial Governments cannot afford to ignore the provision of the Food Adulteration Acts framed by the Centre for the guidance of provinces and states.

CHAPTER XXVII

MILK TESTING

1182. Need for milk testing : For every establishment having to do with the handling of milk some simple methods are necessary to be adopted not only for detection of adulteration but for guidance of the future handling of milk, for the manufacture of milk products. Even when milking is done in one's own establishment, testing is necessary in order to understand the performance of the cows as regards their capacity to deliver milk with high fat-content, because fat-content of milk varies with animals. With a fat-testing arrangement at hand, milk can be purchased on the basis of fat. This does away with the suppliers' tendency to adulterate milk. For, by diluting milk, the supplier only takes the trouble of carrying the load of water without any gain in return when the price is based on the fat-content of the milk.

Examination has, therefore, to be made. Some simple methods, both physical and chemical, are hereafter described which may be conveniently carried out even by those who are not chemists but who want to learn and work scientifically.

The use of scientific instruments and terms is inevitable. Every care has been taken to initiate the novice into the matter. A chemical balance has to be

used and the usual chemical appliances such as beaker, burette, pipette, measuring cylinder, measuring flask, conical flask etc., are also to be used. The beginner should learn the handling of these instruments by receiving instruction from friends who have some knowledge of chemical manipulation. A description of the way to manipulate the various appliances, or a discourse on the art of scientific weighing or analysis, would have taken much space and yet could not have dispensed with the necessity of their practical demonstration. It is suggested that the beginner should learn the use of the appliances by practical demonstration from friends who know, and there are plenty of men who know the practical side of manipulating the appliances mentioned above.

Weights and measures may form a stumbling block. A schedule is given of weights and measures at the end of the Chapter. By studying this the beginner will be easily able to form an idea of what a c.c. is or what a litre measure means.

1183. Sampling : Next is the matter of sampling. Careless sampling will render all subsequent work useless. It has been explained below how the correct sampling of milk is to be taken. If any confusion occurs by once reading these directions for testing, careful re-reading, coupled with a familiarity with the appliances and indicators, and calculation, will make matters easy enough for all persons having the pre-requisite knowledge of mathematics to conduct the tests with fair accuracy. The results obtained will not only reward by helping the management, but

will bring joy for the successful carrying on of manipulation. A layman will be treading the fringe of the field of a scientist.

1184. Care in sampling : In testing milk it is of great importance to take the sample properly. We know that fat rises to the surface when the milk is allowed

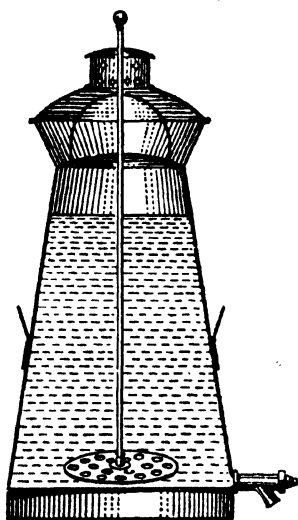


Fig. 55. Milk can with the perforated disc inside for mixing milk before taking the sample.

to rest, so that if the top layer is taken, when sampling, it will not be representative of the milk in the vessel. It will show too much fat. Similarly, a sample taken from the bottom of the vessel will also not represent the quality of the milk, because it will show too little fat. Sampling, therefore, should be made carefully by proper mixing at the time of taking the sample. Pour milk from one vessel to another and back again, and if this is repeated twice or thrice according to the time during which

the milk had been standing or moving, then a quantity taken out of the mixture will represent really the quality of the whole supply.

Where it is not possible to mix the mass by transference as described above, a perforated disc

should be put in and moved up and down a number of times to ensure proper mixing. (Fig. 55)

After thorough mixture a glass tube is to be let in down to the bottom. The top end is to be closed by a finger and the tube drawn out and the contents discharged in the sampling bottle.

Where the sample has to be sent to a distant place for analysis, or when a sample is taken for a legal purpose, for analysis to be made by an outside agency, the milk, sampled as above, should be put in a 4 oz. phial filled to the neck, leaving just a little air space for the cork to be let in conveniently. Such sample phials should be labelled and sealed on the top with a tag, also fastened by the seal, giving particulars of supply, date etc. If the analysis is not done immediately the sample has to be preserved with a chemical preservative.

1185. Composite sampling : When a supplier is paid on the basis of the fat-content of the milk, then such milk has to be tested for fat for every day's supply. Instead of analysing every day, in such cases, what is known as composite sample is analysed. A quantity of sample, proportionate to the supply, is taken with care and is put in a bottle with the name of the supplier. In the same bottle the samples are put in day after day, till a week's supply accumulates for analysis. For the preservation of such samples three chemical substances, all poisons, are used so that the milk may not go wrong. The use of such preservatives is simply for keeping the sample till the time of testing comes.

Chemicals for preserving milk samples.—

(1) *Mercuric chloride or corrosive sublimate.* It is a white powder and is a very virulent poison. Even slight quantities are fatal. A small quantity put in the sample phial will preserve the milk. The drawback with this is the risk of any one using the sample milk through mistake as real milk, and with fatal consequences. It is dangerous also to keep a stock of such a violent poison in unguarded establishments. Its use is not recommended. Where it is used the milk should be coloured with some colouring matter, so that by mistake the milk may not be mixed with any food material.

(2) *Formaldehyde.* It is a powerful preservative. It is also a poison but not in any way approaching Mercuric chloride. The difficulty with this is that the milk begins to clot, and then it becomes difficult to take a sample out of the bulk sampled in the composite sample-bottle for testing. Its use is also not recommended.

(3) *Potash Bichromate.* It is also a corrosive-poison but it gives colour to the milk ; therefore, the coloured sample can never be taken as milk by mistake. A few crystals, put into the phial, will do the work of preserving the sample. It is good both for composite samples or single samples meant for sending out for testing.

1186. Determination of specific gravity: Specific gravity can be found by means of a balance by weighing a quantity of milk in a specific-gravity bottle. For conducting this test with the help of a chemical.

balance, it is necessary to be acquainted with the method of handling the balance. A chemical balance is a delicate instrument. Specific gravity can also be found with the help of a lactometer, a common instrument familiar to many. But one should know how to determine specific gravity with the help of a chemical balance. A balance is a valuable adjunct in any small testing arrangement. Once the skill of weighing with the help of a chemical balance is attained, the finding of specific gravity with its help becomes quite easy.

For the determination of specific gravity with the help of a balance, a bottle, known as the specific gravity bottle, has to be obtained. This is a thin glass bottle with a glass stopper, having a fine hole bored through the stopper. The specific gravity bottle has a brass counterpoise supplied with it which is exactly of the same weight as the empty bottle.

Take the bottle and fill it with milk. Put the stopper in. Excess milk will overflow through the hole of the stopper, and the bottle and the hole will be full of milk. Wipe the bottle clean first with a moist rag and then with a dry rag.

Weigh the bottle, putting the counterpoise on the opposite pan. Any weight put in represents the weight of the milk. The weight of the water that can fill the bottle is written on the bottle itself. Now, we know the weight of a volume of milk and the



Fig. 56.
Specific gravity
bottle.

weight of the same volume of water. The specific gravity is obtained from this. Specific gravity depends upon temperature. The weight of water filling the bottle is taken at a definite temperature, usually 15°C. But in ordinary practice for rough determination, the temperature factor may be ignored. For more accurate work a correction has to be made for temperature.

Calculation :

$$\frac{\text{Weight of milk as found on weighing}}{\text{Weight of water as marked on the bottle}} = \text{specific gravity.}$$

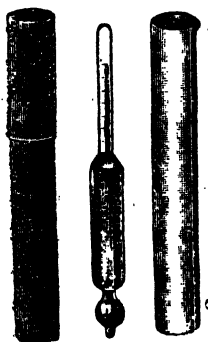


Fig. 57.

Lactometer.

1187. Specific gravity : Lactometric determination : Lactometer is a glass tube with a bulge in the middle ; the bottom is a bulb with a few shots and the top portion is a tube closed at the end and graduated. The markings give the readings of specific gravity. Cheap instruments going by the name of lactometers are mostly unreliable. A reliable lactometer of known make has

to be obtained. One of the reliable instruments is the *Quevenne Lactometer*.

This instrument registers specific gravity from 1,015 to 1,040. The first two digits are omitted. Only 15 is written in place of 1,015. This lactometer, like others, are graduated for a definite temperature. It is troublesome or inconvenient to bring the milk up to the required temperature. Therefore, corrections

have to be made for difference in temperature. This particular instrument is graduated for 60 degrees Fahr. When the lactometer is used for other temperatures, add 0.1 to the reading for every degree above the 60 degree temperature, or subtract 0.1 from the reading for every degree below the 60 degree.

For example, if a milk is at 80 degree Fahrenheit and shows 28 lactometer reading, we have to add 0.1 for every degree above 60 or we have to add $20 \times 0.1 = 2$ to the reading. The corrected reading at 60° Fahr. would then be $1,028 + 2 = 1,030$.

Where the actual lactometer reading at a particular temperature is not aimed at but only a comparative difference between the samples is desired, then a record of the sample reading will do. The different samples must be at the same temperature.

Milk just received from the udder is warm. It takes time to cool down. As the temperature will cool down the lactometer reading will rise. Therefore, for any comparison to be true, a thermometer reading of the temperature of the milk becomes a necessity.

If, therefore, you use a lactometer, have a chemical thermometer also. The thermometers are graduated according to two scales—Centigrade and Fahrenheit. Fahrenheit degree may be converted into Centigrade by the following formula :

$$(\text{Fahrenheit degree} - 32) \times \frac{10}{18} = \text{Centigrade degree.}$$

The reverse formula for conversion of Centigrade to Fahrenheit is the following :

$$\text{Centigrade degree} \times \frac{18}{10} + 32 = \text{Fahrenheit degree.}$$

Choose a thermometer with marking of either

Fahrenheit or Centigrade scale suitable for your other work also. It should be noted that a physician's thermometer, called a clinical thermometer, is useless for our purpose here. A clinical thermometer will be necessary in a dairy for taking the body temperature of the cattle. For the purpose of determining the temperature of milk a chemical thermometer is a necessity.

1188. The sediment test : It is an excellent plan when buying milk to make periodical test of milk for the amount of insoluble dirt present. There is nothing which will prove so effective and demonstrate so clearly the need for cleanliness as seeing the dirt removed. A simple test is as follows :

A cylinder open at both ends is made to hold a required amount of milk, usually $1\frac{1}{2}$ lbs. At one end of the cylinder is fitted a small piece of wire gauze which clasps on to the end, forming a strainer. Before the gauze is clasped on to the neck a small disc of cotton wool is placed on it. When the cylinder is fixed on a stand, ready for use, the milk is poured in at the top. It flows through the piece of cotton wool. The disc may be dried on blotting paper and preserved. The milk should be warm *i.e.*, 100°F .

It must be remembered that this will show only the portion of dirt that does not get dissolved in the milk.

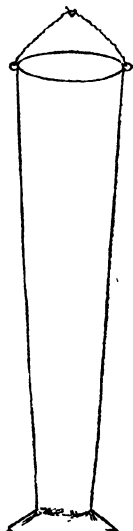


Fig. 58. Sediment Tester.

It will make evident the extent to which cleanliness is observed in procurement.

1189. Reductase test : Milk contains bacteria. They multiply rapidly by division. Bacteria are found everywhere in Nature and they are present in the freshest and cleanest of milk. In the udders there are not many present, but in the canal of the teat they are present in millions. Bacteria enter milk from the teats, from the milkers' hand, from vessels, from dust, and from flies. Lactic acid bacteria makes the milk sour, and the extent of acidity of the milk is worthy of determination. When the acidity increases a certain limit, milk coagulates on heating. Acidity continues to increase all the time the milk is standing in the warm atmosphere of our country. Cold inhibits the growth of bacteria. In cold countries, therefore, it is easy to keep milk longer without souring and without enormous growths of bacteria.

It is worthwhile to know the bacterial condition of milk as you receive it, apart from acidity which forms the subject of another test.

Milk contains naturally some enzymes, and other added bacteria also produce enzymes by their secretion. These enzymes may bring about considerable changes in the milk by their presence even in minute quantities.

Reductase is a variety of enzyme produced by micro-organisms in the milk. It is so called because it has a reducing effect and its presence can be shown by the decolorisation of certain dyes. Methylene blue is one of those dyes that are reduced and decolorised

and is, therefore, used for the determination of the bacterial contamination in milk.

(1) Dissolve 1 part methylene blue in 2,000 parts or $\frac{1}{2}$ gram in 1000 c. c. or one litre of water.

(2) The above is a stock solution. For purpose of test, dilute 1 part of the stock solution with 9 parts of water. For these scientific measurements the tester will have to keep a set of graduated cylinders marked with c.c. from 1 to 100 and a measuring flask of 1,000 c. c.

(3) Take 10 c. c. of milk in a test tube and put 1 c. c. dye solution in it.

(4) Put a little paraffin oil on the surface of the milk in the test tube which will entirely cover up or seal the milk surface from contact with air.

(5) Put the test tubes in the water, and watch for a change of colour, noting the time.

Results : Bad milk will decolorise in 20 minutes. The better the milk, the less the bacterial contamination, the longer will be the time taken to decolorise. The time taken gives a measure of bacterial contamination.

The following Table gives concisely the four grades of milk with their sanitary qualities, reduction times, and approximate bacterial counts per c. c. :—

TABLE—122

Table of sanitary quality of milk

Grade.	Quality.	Reduction times.	Bacterial count per c. c. (approximately).
I.	Good milk	5½ hrs or more	500,000 or less.
II.	Milk of fair average quality	2 to 5½ hrs.	from 500,000, to 4,000,000.
III.	Bad milk	20 minutes to 2 hrs	from 4,000,000 to 20,000,000.
IV.	Very bad milk	20 minutes or less	20,000,000 or more,

1190. Determination of fat-content of milk—Gerber test : The most convenient method of testing fat is to separate it from the milk in the same way as is done in a cream separator. For this purpose a centrifugal machine, specially built, is used. A measured quantity of a sample of the milk to be tested is also placed in special tubes.

The tube containing the milk is rotated at a high speed in the centrifugal machine. The centrifugal force drives the fat towards the end of the tube which is narrowed there. The quantity of fat is read out from the space occupied by the fat in the narrow graduated portion of the tube in terms of percentage of milk.

In actual operation it is found that separation by the centrifugal force needs to be hastened. Another necessity is found of increasing the difference in the specific gravity of milk plasma and fat. If the milk plasma becomes heavier, fat separates out quickly. And yet another factor is the disturbing influence of casein. Casein seems to clasp the fat globules. If casein could be made to part with this property, then the separation of fat would be better and quicker. Lastly, rising of temperature helps fat separation. All these objectives are attained in a simple way by the mere addition of an equal volume of concentrated sulphuric acid to the milk before putting it for centrifuging.

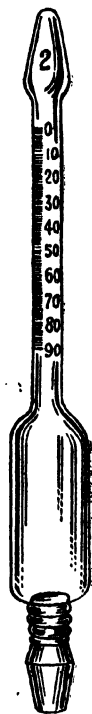


Fig. 59.
Gerber
tube.

"The principles involved in the Gerber method are the solution of protein and mineral matter in sulphuric acid, the solution of the fat in hot amyl alcohol and its separation from the heavier acid solution by means of centrifugal force. Bottles, re-agents, and general procedure are all specified,

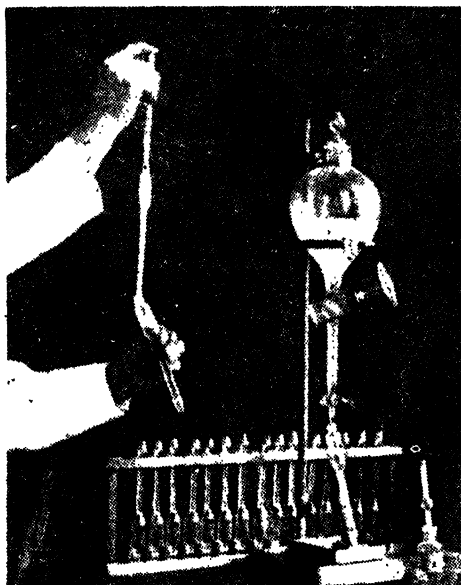


Fig. 60. Filling the Gerber tube.

and there should be little or no deviation from the original recommendations, if accuracy is to be desired. The apparatus required for the estimation is as follows :

"1. Gerber tubes of glass as illustrated in Fig. 59.

The graduated stem of these tubes is calibrated to read from 0 to 7 or 8% of fat. . . ."

"2. Pipettes to measure 11 ccs. of milk, 1 cc. of amyl alcohol, and 10 ccs. of sulphuric acid. The two latter may be automatic in order to speed up the test, or if ordinary pipettes are used, they should have two bulbs at the top in order to prevent the objectionable liquids entering the mouth as a result of too rapid suction. It is an advantage to have the amyl alcohol pipette short enough to admit 1 cc. by merely lowering it into the amyl alcohol bottle, so avoiding the necessity of drawing up the liquid with the mouth, besides saving a considerable amount of time in measuring.

"3. Wooden stands to hold the Gerber tubes and pipettes. These are especially necessary for pipettes, because once the tips are broken they become useless as measuring instruments.

"4. Water bath and stand to enable the Gerber tubes to be heated to 149° F. before reading.

"5. Centrifuge to contain 8 or 24 tubes, which may be whirled at 1,000 revolutions per minute by hand or power.

"The reagents required are (1) commercial brimstone sulphuric acid of specific gravity 1.820 to 1.825 at 59°F. diluted to a strength of 90 to 91% H_2SO_4 . Acid of this strength may be obtained by careful dilution with water in the proportion of about 16 volumes of water to 200 volumes of strong commercial acid.

As, however, the strength of a strong commercial acid is not constant, these proportions may be subject to some variation.

"(2). Pure amyl alcohol free from petroleum, of specific gravity 0.8165 to 0.818 at 59°F., boiling between 124 and 130°C. By the use of amyl alcohol, the fat separates quickly in the form of an amber-coloured solution.

"Procedure.—

Run 10 ccs. of the sulphuric acid into the Gerber tube, return to the stand, and then add 1 cc. of amyl alcohol.

"In adding these reagents, care must be taken to avoid contact with the threaded

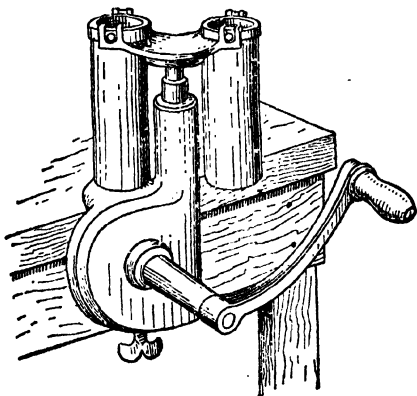


Fig. 61.

Centrifugal machine.

neck of the tube. Measure 11 ccs. of well-mixed milk by means of a pipette, and by tilting the Gerber tube, insert the point of the pipette into the tube clear of the neck (Fig. 60). Allow the milk to run out slowly from the pipette so that the three liquids may be distinguished as separate layers in the tube. It is necessary to avoid a rapid discharge of milk into the

tube, since it leads to a considerable amount of charring which obscures the junction of the fat column with the acid, after centrifuging. Firmly insert the cork, and gripping the tube by the stem, briskly shake the contents..... Mix the acid in the stem with the remainder by inverting once or twice, and after a few moments brisk shaking, during which a considerable amount of heat is generated by the mixing of the acid with the water, place the tube in a centrifuge, stem towards the centre, and rotate for three minutes at 1,000 revolutions per minute. After centrifuging, place the tube stem upwards in the water bath, heated to the temperature engraved upon the Gerber tube and leave, for a few minutes to attain this temperature. Remove the tube, and raise or lower the cork until the bottom of the fat column is brought against a unit graduation, when the reading of the *bottom* of the upper meniscus may be taken. Subtraction of the lower reading from the top one gives the percentage of fat.

“Observations.—Students often experience difficulty in manipulating the corks, being either too gentle in inserting them, so that they are forced out when shaken, or forcing them in so far that they are unable to manipulate them in order to read the fat column satisfactorily. ...”

“If the acid used is too strong, charring will occur, and it will be difficult to distinguish the fat column from the rest of the liquid. If too weak, the

acid will not dissolve all the coagulated protein, so that again there will not be the desired sharp differentiation between the fat and the acid liquid.

"Errors are sometimes introduced through the amyl alcohol containing petrol, and it is always advisable to run a blank estimation with 10 ccs. of acid, 11 ccs. of water, and 2 ccs. of amyl alcohol, in which case there should be no separation of oily matter.

"The Gerber tubes should be checked occasionally against one standardised by the National Physical Laboratory, using samples of milk ranging from 1 to 6% of fat. The necessary corrections for each tube at each part of the stem should be recorded.

"It is essential in this method, as indeed in all methods involving the measurement of volume, to read at the bottom of the meniscus, whether in pipettes or Gerber tubes. Further, when measuring with a pipette or reading off the percentage of fat from the Gerber tube, it is essential to measure or read with the meniscus in question on a level with the eyes."—(Edgar.—*A Text Book of Dairy Chemistry*. P. 141-'46).

AFTER THE TEST : Wash rubber stoppers in warm water and washing-soda ; rinse in clean water, and dry with a cloth. Shake butyrometers to dislodge sediment, empty them, and wash with warm water and soda. Use a brush. Rinse in clean water and allow to drain in a rack.

1191. **Testing milk for acidity :** *Acids and alkalies.* Milk gets sour on keeping for sometime. This is due to the action of lactic acid bacteria. It must not be supposed that only lactic acid bacteria work upon the milk. There are simultaneous actions of other micro-organisms also which contribute to the

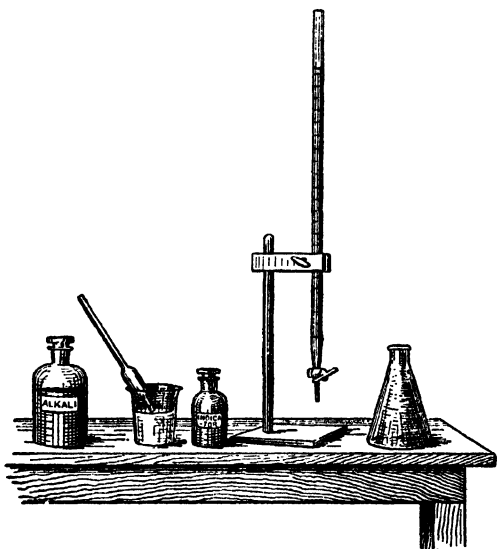


Fig. 62. Apparatus used in the Alkaline test for Acidity.

spoilage of the milk by the formation of undesirable products. Lactic acid bacteria cause the milk to sour or become acid, and we are concerned with this. There is a sugar in the milk called lactose. Lactic acid bacteria break up this sugar and convert it into lactic acid. Souring or acidity progresses by degrees.

When acidity has attained to 0·26 per cent, milk can no longer be heated without coagulation. Bacteria continue to grow and develop acidity in milk till a concentration of 0·9 per cent is reached. When milk is nearly 1 per cent acid (·9 per cent) lactic bacterial growth is inhibited. This is the maximum acidity of milk. Bacteria do not die thereafter but remain. If the acid is removed or neutralised, they again begin to multiply and produce acid. Therefore, it is imperative that in handling milk the stage of its acidity should be known. Milk naturally contains some acid salts, which give it very faint or very slight acidity which is called "apparent acidity." Total acidity is the acidity due to this apparent acidity, and the acidity due to lactic acid formation.

Acids and alkalies are opposing substances. Alkali destroys acidity. So that if some known quantity of alkali is used to destroy the acidity of milk, it will give a measure of the acidity of the particular sample.

1192. Neutralisation in acidity testing: Acids are familiar to all. Sulphuric acid is an acid, citric acid, the acid juice of lemons, is an acid, and vinegar is an acid called acetic acid. Similarly, the names of hydrochloric and nitric acids are familiar. Caustic soda is an alkali. Lime water is an alkali. When alkali is added to acid, the alkali combined with the acid destroys its acid character and itself loses its alkaline character, and the combined product of the two substances is chemically called a salt.

Lactic acid may be opposed by caustic soda, an alkali. When these two mix so as just to destroy

the acidity, then there is no alkalinity either, and the combined product or the salt produced is a lactate, in this case sodium lactate.

1193. Indicators : In determining the acidity of milk, we need, therefore, caustic soda of known strength. We need besides some indicator which will tell us whether acidity has ended or some substances which will visibly demonstrate to us the presence of alkali or acid.

Litmus paper is such an indicator. It is a vegetable dye. When blotting paper is dyed with litmus it is called litmus paper. Litmus paper becomes blue in contact with alkali and red in contact with acid. If a stock of blue and red litmus paper is kept, then by using them we may test whether a substance is acid or alkali. Turmeric to an extent serves the same purpose. It turns red with alkali. If moist turmeric is rubbed over blotting paper, turmeric paper indicator is made.

Qualitative test for acidity : By simply dipping a piece of blue litmus paper in milk, the change to redness will be observed indicating acidity. The deeper the redness the greater is the acidity. Simply by the use of the litmus indicator paper, a fair but rough idea of the acidity of milk may be obtained. By dipping the indicator in various strengths of acid, .5, 1, 2 and 3 per cent, the eye can be trained to judge roughly about the acidity. The tongue may, if trained, also help. Putting a few drops on the tongue will enable one to detect and also to roughly determine acidity.

For the quantitative test of acidity another and a more delicate indicator is used. It is phenolphthalein solution. Phenolphthalein is a powder, soluble in alcohol. 10 grams of phenolphthalein dissolved in 250 c. c. of alcohol will make the indicator. It remains colourless in acid but is turned pink to bright red by alkali. Faint alkali gives a pink tint. As alkali increases the colour changes by degrees to bright red.

1194. Acidity test : For testing the acidity of milk we need a standard solution of alkali or caustic soda. 4 grams of caustic soda in one thousand cubic centimeters of water (1 litre) will give the required solution. In this case it is one-tenth normal solution, written as N/10 caustic soda. 1 c. c. of this solution exactly neutralises .009 gram of lactic acid. Therefore, as many c. c. of this solution that are needed to neutralise a definite quantity of milk sample, so many .009 grams of lactic acid are in that sample. In order to make the standard N/10 caustic soda solution, the alkali has to be accurately weighed out. A chemical balance and a set of gram weights are necessary. Caustic soda destroys skin and paper and eats into brass. It should not be handled by the hand, but by an iron spatula or be held by iron forceps. For weighing, the substance is to be put in a crucible or a watch glass, to avoid contact with the pan of the balance. The crucible is to be tared. Pure caustic soda from chemists should be obtained for analytical work. Commercial caustic soda will not do, as it contains a lot of impurities. If pure caustic soda in flakes is obtainable it will be best for weighing out definite

quantities. Caustic soda is hygroscopic and absorbs moisture. The original bottle should be carefully kept corked. Caustic soda is acted upon by carbonic acid gas of the air which converts it into a carbonate.

In making standard solution use distilled water. Ordinary water contains substances which may precipitate a portion of soda. Distilled water should be boiled and cooled to free it from dissolved air before making the N/10 solution.

Definite quantities of this standard alkali is to be measured out in a definite quantity of milk sample. For measuring out, an appliance called burette is used. It is a long tube with a tap at the bottom. The tube is graduated in c. c. or cubic centimeters. A 25 c. c. burette may be used. The burette may be closed at the bottom with a glass cock or a rubber tube and a pinch clip. For caustic soda a rubber tube and pinch clip should be used because the alkali may make the glass cock stick hard to its socket and ultimately make it unusable. If, however, a glass-stoppered burette is used, the stopper should be kept fully lubricated with a coat of vaseline on the contact surface of the glass. This film is to be replaced with a fresh coat at the time of storing away the burette.

A solution of standard alkali is put in the burette, and by releasing the cock it is allowed to run down on the sample placed in a porcelain basin or a conical flask.

17.5 c. c. milk is to be run out from a burette. This corresponds to 18 grams of milk. Into the 17.5 c. c. milk in the basin or flask is put, say,

4 or 5 drops of phenolphthalein indicator. There will be no change in colour as the milk is acid. Take a glass rod and stir the contents of the basin with it. If a conical flask is used, and it is better to use a conical flask, give a rotary motion to the contents for thorough mixing. Add on alkali drop by drop from the burette till a faint pink taint appears. By a rotary mixing motion the colour will disappear ; add a few drops more till a permanent pink colour is obtained, and read off the number of c. c. used.

By allowing the tested (titrated) solution to stand, after a short time the pink colour will disappear. The reason is that after the test more lactic acid has been made by the bacteria. The standard solution had not killed the bacteria but had only neutralised the acid. The bacteria, on neutralisation of acid, works more vigorously to produce more acid, and hence the de-colorisation.

Calculation : Multiply the number of c.c. of standard solution used by 0·009. This will give the quantity in grams of lactic acid in the milk sample of 18 grams. Then calculate : 18 grams has so may grams of acid, therefore, 100 grams has so many grams of acid. The result gives the percentage of lactic acid in the sample.

Formula for Percentage of acidity =

$$\frac{0\cdot009 \times \text{c.c. of alkali used} \times 100}{18 \text{ grams (milk)}}$$

(if 18 grams or 17·5 c.c. were taken)

1195. Acidity determination by lime water : A quicker and simpler way of determining the acidity of

milk is to use lime water as the standard alkali solution. The test is carried out as under.

A quantity of lime is placed in a bottle which is very nearly filled with water. The bottle is shaken, by which lime dissolves in the water to saturation. After vigorous stirring for some time the liquid is allowed to settle down. The clear liquid at top is lime water of our test. The same water from the bottle may be used, if it is shaken and kept at rest from time to time.

Take 17·5 c.c. of milk in a white basin. Add 4 to 5 drops of phenolphthalein. Add on lime water from a graduated cylinder and stir continually till a delicate pink tint is obtained. The number of c.c. of the lime water used is then read.

$$\frac{\text{c.c. of lime water}}{50} = \text{percentage of acidity.}$$

1196. The freezing point test : The composition of milk varies greatly, and it has been shown that there are innumerable factors upon which the composition of the milk depends. In this diversity there is one unity preserved, in the matter of the freezing point. Freezing point is the temperature at which a substance begins to solidify or freeze. The freezing point of milk is constant within a narrow margin, being between $-0\cdot53$ to $-0\cdot55$, or about half degree below zero degree centigrade. The milk of all animals in all climates conforms to this freezing point. When water is added, the freezing point is disturbed ; it rises. If a milk is found to be above $-0\cdot53$ degree centigrade then the conclusion is that the milk is adulterated with added water. The freezing point is independent of

fat-contents and, therefore, whole milk and skimmed milk ought to show the same freezing point. Milk adulterated with skimmed milk will not answer to this test and will pass as genuine. Only when water is added, does the test become useful in its detection. A quantitative ratio has been found to exist between added water and the rising of the freezing point. The test is not new, neither is it new in India. But, probably owing to its limited applicability it has not made much progress. As long ago as 1915 Dr. J. N. Leather determined the freezing point of cow and buffalo milk at Pusa and found the average to be as under :

Cow	...	-0.542°C.
Buffalo	...	-0.541°C.

In 1930 Stewart and Banerjee suggested that, -0.53°C. should be taken as the maximum limit of freezing point in the case of Calcutta milk from cow or buffalo.—(Agarwalla.—*A Laboratory Manual of Milk Inspection*. 1940. P. 44).

Agarwalla gives the following Table of the percentage of added water for different rises in the freezing point.

TABLE—123

Variation of freezing point due to water admixture.

Temperature in Centigrade.	Added water per cent.	
-0.565	...	2
-0.543	...	4
-0.530	...	5
-0.506	...	10
-0.490	...	15
-0.485	...	20
-0.450	...	25

Freezing points of milk of different animals.

Degree in Centigrade.		
Buffalo	...	-0.56 to -0.59
Cow	...	-0.55 to -0.58
Goat	...	-0.55 to -0.59
Woman	...	-0.55 to -0.59

It appears that the matter has not been definitely ascertained about the percentage of water admixture, corresponding to a rise of the freezing point. The figures given by Leather are different from the figures given by Stewart and Banerjee. The consensus of opinion is that when milk has a freezing point above -0.53, the presumption is of adulteration with added water. Research work is being carried out in India to standardise the freezing point test. The Board of the Imperial Council of Agricultural Research passed a resolution (1941-'42 Report) to the effect that the freezing point test should be further studied, recommending the resolution to the Provincial and State Governments and the Indian Institute of Science.

It is not intended to describe the test here. It is not possible to be carried out by those for whom this book is intended and for the sort of laboratory contemplated. The method needs the use of a thermometer reading one-hundredth degree of centigrade. The apparatus used is a flask in which a quantity of ether is allowed to freeze by bubbling air through it. In this freezing fluid dip a metal tube containing a glass tube in which is introduced

a few c. c. of milk for freezing point determination, provided with a thermometer reading to $\frac{1}{100}$ th degree centigrade and a stirrer, while a control thermometer is used giving the reading of the freezing fluid, which is to be kept at a temperature lower than that of the freezing range. In another method a mixture of ice and salt is used in the other jar, the inside tube holding the milk, the thermometer and the stirrer. A Beckmann thermometer is used or the specially constructed thermometer of Hortvet, fitted to the special apparatus - "Hortvet's cryoscope".

When there is a necessity for the determination of added water, the sample may be sent for the freezing point determination to the nearest laboratory equipped with the cryoscope. The milk must be fresh for cryoscopic determination. It is said that preservation with mercuric chloride does not interfere with the test.

1197. Testing for total solids and solids-not-fat : A quantity of milk is weighed out, say, 3 to 5 grams. It is evaporated to dryness. The loss in weight is found by re-weighment after drying. The weight left after the evaporation of water is the weight of the solids of milk in the weighed sample. From the original weight of milk, and the weight of solids in it, the percentage of total solids in the milk is calculated.

After the determination of fat from the same sample of milk, the fat percentage found out is deducted from the total solids percentage, which gives the solids-not-fat or the S. N. F. of milk.

Process.—Weigh out 5 grams of milk in a previously weighed and thoroughly dry basin. Take an air oven with a thermometer. Heat the oven so that a constant temperature of 100°C . is maintained. Put the basin on the oven and watch from time to time. If a scale is formed, break it with the help of a needle. After a time all the liquid will dry off, leaving only the solids in the basin. Take it out of the oven and put in a dessicator.

The dessicator contains strong sulphuric acid in its well at the base which keeps the air in it free from moisture. The hot dry basin is put in the dessicator to cool down in a dry atmosphere. When cold, take out the basin, weigh it and note down the weight. Put the basin again on the oven and heat it for half an hour at 100°C ., take out, cool in the dessicator and weigh. This last weight must be the same or constant as the previous one, if all moisture had been driven out. If not, heat again till the constant weight is obtained. By subtracting the weight of the basin from the weight of the basin and the solids, the weight of the solids is obtained. So much weight of milk gives so much solid, therefore, 100 of milk gives so much solid is the way of calculation. A calculation is made on this basis which brings out the percentage of total solids in the milk. Deduct percentage of fat from it to obtain solids-not-fat.

In milk there is a constant ratio between the lactometer reading of specific gravity and the fat percentage and total solids. So that if the lactometer reading and fat percentages are known, the total solids

are found out. This formula is called Richmond's formula and stands thus :

Percentage of total solids = $\frac{G}{4} + \frac{6F}{5} + 0.14$ which, as modified by Fleischmann, stands as under :

$$\text{Percentage of total solids} = \frac{G}{4} + \frac{6F}{5} + 0.25.$$

G = Lactometer reading. F = percentage of fat.

If the specific gravity at 15°C. and the fat percentage are known, the total solids are calculated out.

1198. Weights & Measures : The weights used in chemical analysis are grams and their fractions or multiples, and the measures are in cubic centimeter, its fractions or multiples. One cubic centimeter (c.c.) of water at 4°C. exactly weighs 1 gram. A centimeter again is a measure of length. A block of water one centimeter in length, breadth and height is a cubic centimeter. The weight of this is one gram. A schedule of equivalent weights and measures is given below :

Measures of Length.

1 inch = 2.5399 centimeters (= 2.54 approx.).

1 foot = 30.4794 centimeters (= 30.48 approx.).

1 yard = 91.4388 centimeters or 0.914 of a metre.

To convert inches into centimeters,
multiply by 2.54.

1 centimeter = 0.3937 inches.

1 metre = 100 centimeters = 1 yard and 3.37 inches.

To convert centimeters into inches, multiply by 0.39.

To convert metres into yards multiply by 1.09.

Measures of Weight.

- 1 grain = 0.0648 grams.
 = 64.8 milligrams.
 1 dram = 3.888 grams.
 1 ounce = 28.35 grams.
 1 pound = 453.592 grams. Roughly $\frac{1}{2}$ kilogram.
 1 kilogram = 1,000 grams.

To convert ounces (Avoir) into grams
 multiply by 28.35.

To convert pounds into grams multiply by 453.6.

To convert pounds into kilograms multiply by 0.454.

- 1 milligram = 0.0154 grains.
 1 gram = 15.43 grains.
 = 0.0321 ounces.
 1 kilogram = 1,000 grams.
 = 2.2046 lbs. (Avoir.).

To convert grams into ounces multiply by 0.0352.

To convert grams into grains multiply by 15.432.

To convert kilograms to pounds multiply by 2.2046
 or roughly 2.2 lbs.

Measures of Capacity.

- 1 fluid dram = 3.544 cubic centimeter (c.c. or mil.).
 1 fluid ounce = 28.412 c.c.
 1 pint = 567.933 c.c. or 0.568 litres.
 1 gallon = 4.54 litres.
 1 litre = 1,000 c.c. or mil.
 = 35.196 fluid ounces.

To convert ounces into c.c. multiply by 28.412.

To convert pints into c.c. multiply by 568.0.

To convert gallons into litres multiply by 4.54.

1 cubic centimeter = 1 gram distilled water at 4°C.
= 0.061 cubic inches.
= 0.0352 fluid ounces.
= 16.896 minims.

To convert c. c. into ounces multiply by 0.0352.

To convert litres into pints multiply by 1.76.

To convert litres into ounces multiply by 35.196.

1 c.c. = $\frac{1}{1000}$ litres = 1 millilitre (or 1 mil.)
= 1 gram distilled water at 4°C.

1 gallon = 10 lbs. of water occupying 277.274 cubic
inches (4.54 litres).

Indian Weights.

1 Rupee = 1 tola = 180 grains.

1 maund = 40 seers = 82 lb. 2 oz. 3 dram.

1 ton = $27\frac{1}{2}$ maunds.

Weights below 1 gram.

1 milligram.

1 centigram.

1 decigram.

Gram.

Kilogram.

1 c.c. to

1,000 c. c. = litre.

Metre.

Millimeter

to Kilometer.

CHAPTER XXVIII

URBAN MILK SUPPLY

1199. **Different aspects of city milk supply :** In any matter of consideration for the improvement of the lot of our cows, the city comes in inevitably. Although the population is small compared with the entire population, the draw that this urban population makes upon the resources and economics of the country is enormous. For the supply of milk to the cities a very large number of cattle are imported over long distances. They are used for one lactation and then slaughtered. This is one aspect of the milk supply of cities like Calcutta, Bombay Madras, Karachi, Cawnpore etc.

Another aspect of city milk supply is that cows are made to live in an insanitary condition and the milk becomes unhygienic. Cruelties are practised on them, and their calves are starved to death. A common problem of city milk supply, apart from the consideration of cows, is its adulteration.

These and several connected matters have been arresting the attention of the Municipalities and those interested in the welfare of animals. Repeated attempts have been made, but up till now not a ray of hope has shone regarding the solution of the problem of urban milk-supply. On the contrary, things are continuing to get worse and worse year after year. True,

there has been a legislation applicable to Calcutta making *phooka* a criminal practice punishable with imprisonment. But enactment is one thing and its actual translation into action is another thing. The best of laws may leave us unaffected if the enforcement of law by moral and legal pressure is not brought about.

To the humanitarian, the thousands of cows of excellent breed that are slaughtered is a sore point. Those who have no objection to cow slaughter also find the practice of slaughtering useful cattle very wrong and want to stop indiscriminate slaughter. Animal-husbandrymen with eyes on the future improvement of the cattle, get shocked on seeing so many fine young stock starved to death. Some of them feel this more keenly even than the matter of slaughter of the cows.

1200. **Pernicious system of city milk supply :**
Mr. William Smith, Imperial Dairy expert, observed :

"In Calcutta and Bombay practically the total fresh milk supply of the city is produced from cows fed, housed and milked right within the city. * These cattle are purchased in the prime of life and generally with their second half at heel, they are milked for one lactation period only, say, 9 months, and then immediately slaughtered to make room for another cow just calved, which, of course, shares the same fate as her predecessors, and so the pernicious system goes on. ... Within the last 15 years, it may be taken that *the cow feeding*

* (Now estimated to be 60 per cent. Milk Marketing Report 1941-42)

system of milk production in our largest cities has caused the slaughter of not less than 2,50,000 young cows and female buffaloes."

—(Manian.—*Cattle Wealth of India*. P. 33).

1201. Salvage of dry-cows: In Bombay, it is asserted that hardly 25 per cent of the dry cattle are sent to the interior, and 75 per cent are sent to the butcher. For Calcutta, where there is no system to return the dry cow to the rural areas, practically 100 per cent of the dry cows of the city are slaughtered. In cities, milk is almost invariably associated with slaughtered cows and starved calves. This cruel thing has been going on for decades.

In several meetings of the Animal Husbandry Wing of the Board of Agriculture and Animal Husbandry the question of the salvage of dry cows from cities used to come up for discussion. At last the matter was allowed to repose with a resolution that a Committee will visit the cities and formulate a plan for submission. This was in 1939. For some reasons the Committee could not commence work. It is recorded in the annual report of I. C. A. R. 1941-'42 that a Committee appointed for the salvage of city milch cattle visited several localities in and around the city of Madras where milch cattle were kept; the report of this Committee is expected to be published. In the meantime the "Report on the Marketing of Milk" has come out which has a full and detailed scheme for solving the problem of supply of milk to the cities and towns, and which also proposes to solve the problem of the salvage of the city milch cattle.

This question had been considered from various angles very thoroughly at Bombay, and much spade work had been done there to have a beginning. Mr. Z. R. Kothawalla was at the time the Dairy expert of the Bombay Municipality. For the 1939 meeting of the Animal Husbandry Wing, he, then the Imperial Dairy expert, at Bangalore, prepared an elaborate set of papers giving his own suggestions backed by detailed reports of the very serious endeavours of the Bombay Corporation in the matter. Those who are interested in the history of the Bombay efforts to understand the intricacies and the difficulties of the problem, will do well to go through these papers in the proceedings referred to above.

1202. Bombay milk supply schemes : The story of the Bombay efforts has been briefly sketched in the Report of the Marketing of Milk (1941-'42) also.

The Corporation of Bombay has been considering schemes for better milk supply and for the saving of prime cows for the last 20 or 25 years. In 1920, it prepared a scheme for expending about 3 lakhs of rupees for erecting cow-sheds outside the city in the Trombay area for housing 5 to 6 hundred milch cattle with an attached ground of 300 acres. The scheme could not materialise as it was found later on that the scheme could not materially help the prevention of slaughter of milch cows, for which the scheme was principally intended, and also because it was apprehended that the scheme could not even help in reducing milk prices. The scheme was abandoned.

Another scheme came up for opening a large dairy at Telegaon near Poona with a capital of 10 lakhs, to which the Corporation was to subscribe 2 lakhs of rupees. This scheme required the Corporation to guarantee a dividend of $5\frac{1}{2}$ per cent for 10 years, it having a lien on the profit exceeding 10 per cent, for making good past guarantee of losses. This scheme met a legal check because the Corporation had no power to spend money outside of its own area. The law was changed subsequently so as to provide for cases like this. But when ultimately the law was changed a new scheme was put up requiring a minimum quantity of milk supply per day. The minimum was a heavy one, being 1,00,000 pounds per day. It was a big demand and for one reason or another no company could be brought to existence to work under the scheme. There was an attempt after this to invite offers for supplying milk to the city with or without subsidy. But this scheme also could not find a sponsor.

Lastly, the Corporation got a scheme from the Bombay Co-operative Milk Union to work on a subsidy basis. Cattle stables were to be erected outside the city at Kandivli having 185 acres of land for pasture, out of a total of 200 acres demanded for the scheme. The selling price of milk was to be $4\frac{1}{2}$ annas per seer, delivered in sealed bottles. Doubts were entertained about the success of this scheme, and it fell through.

The position remains today where it was with difficulty growing on account of the increase of population in the city. At present 25,000 milch

animals, cows and buffaloes, are maintained within the Corporation limits under very insanitary conditions, and what falls to the lot of these 25,000 animals and their progeny every year is well-known. In one day I counted sixty calves in the scavenging yard for entrainment to the Chemur dead cattle disposal yard, and this number is thought to be lower than the average.

The Bombay schemes failed because no subsidy could protect the contractor from the competition of the *gowalas* keeping milch animals within the town. If adulteration was to go on, there was no prospect of any pure milk supplying organisation doing large business profitably in competition with the unscrupulous producers or dealers. How ineffectively the law for the prevention of food adulteration operated, is well-known.

1203. Co-operative milk supply : To some, the co-operative system supplied a solution of the city milk supply question. If *gowalas* in the rural areas wanted to supply milk to the cities, they, by combining and forming co-operative societies, could supply milk at a price which could bring them profit, and the city could get pure milk from societies under Government control.

Government fostered the formation of Co-operative Milk Societies and there are about a score of them in existence in India which are of some importance.

"All of them have been established through strenuous efforts of the officials of the Provincial and State Co-operative Departments who even now

constantly guide and supervise their work.”—(*Milk Marketing Report*).

1204. Co-operative Societies are failures : In spite of all official efforts, these societies, some of which were established soon after the Co-operative Societies Act of 1912 came into operation, are not doing well. The volume of business turned over by them is insignificant, except for the two Calcutta and Madras Unions. Even these handle 1·8 per cent and 6·9 per cent respectively of the total daily milk supply of these two cities.

TABLE—124

*Proportion of “Co-operative” to “market” milk
at some of the important centres.*

Milk Union.	Date registration.	Year to which the figures relate.	Quantity handled annually by co-op. organisation. Mds.	Annual quantity of market milk excluding ghee. Mds.	Percentage handled by co-operative milk to total milk organisation.
Calcutta	1919	1936-'37	38,183	21,10,065	1·8
Madras	1927	1938-'39	32,236	4,70,120	6·9
Lucknow	1936	1938-'39	5,663	4,38,730	1·3
Allahabad					
(Society)	1913	1936-'37	2,943	3,04,410	1·0

The societies that are tabled here are the largest ones, and yet they play so unimportant a part in the city milk supply. The Milk Marketing Report deals with these societies exhaustively. The reading of the report leaves the impression in the mind that almost all of them are failures. The reason also is not far to seek. It appears that they are not really Co-operative

Societies. These societies are fostered by men in towns much in the same way as limited companies are promoted. Some city people get together and call themselves an Union which register suppliers of milk in different villages. The suppliers are similarly called societies. The relation between the town body and the village society which in essence is a loose group of milk producers, is really one of buying and selling. There is no feeling of one-ness in the organisation. Because it is so, therefore, strikes can take place as between the town managing body and the producers, the producers striking and refusing to supply milk to themselves. The Madras Co-operative Milk Societies Union Ltd., for example, suffered from a strike.

“Matters in one year (1929) were so bad that due to outside influence the members stopped the supply of milk to the Union for sale to hospitals. This position lasted only for a few weeks but the Union had to pay damages to the hospitals to the extent of Rs. 10,000/- for failure of supply.”

This is about Madras. The Calcutta Union is not in a very much better position as the following from the Milk Marketing Report on the Calcutta Co-operative Union will show :

“It is also observed that during the periods of scarcity, when they can obtain higher prices from outsiders, some of the members do not give the milk to the Union, which cannot effectively insist upon the members giving their entire production to it or to prevent outsiders from buying from its members.”

This shows that the members and their societies are alien to one another, having seasonal opposing interests. This cannot be the feature of co-operative organisations.

1205. Telinkheri Co-operative Dairy : Of the co-operative milk societies and unions, of which some details have been given in the Milk Marketing Report, the Telinkheri Co-operative Dairy Society, Nagpur, is one. There were only 18 members of this society who in 1936-'37 were producing amongst themselves 23 mds. of milk daily and purchasing 6 mds. from non-members and handling, therefore, 29 maunds daily against 80 maunds of the Madras Union with 14 societies and 800 members, or against the Calcutta Milk Societies Union handling 104 maunds of milk daily from 123 societies and 8,359 members.

The quota of daily milk supply per member stands thus on analysis :

TABLE—125

Milk contributed daily per member.

	Daily milk contribution per member.	No. of members.	Total daily milk.
(1) Telinkheri	64½ seers.	18	29 mds.
(2) Madras	4·4 „	800	88 „
(3) Calcutta	0·5 „	8,359	104 „

Members who contribute ½ a seer of milk daily, valued at one anna, can have little interest for the welfare and profitable running of the societies in common with the organisers and managers of such societies. There is no common bond as between

member and member and as between a member and the society as a corporate body. In spite of all the good things that appear in the reports, the fact stands out that the co-operative milk societies are little less than registered limited liability companies in their relation to the member-shareholders.

The Telinkheri Dairy Society stands on a separate footing in which every member is a real and active partner concerned in the welfare of the Society. It was organised by the Agricultural Department, obtaining from the Government 900 acres of grazing land. It started with 13 member *gowalas* and 156 milch cattle. In 1940, there were 18 members with 759 milch cattle. The Society is really of the important *gowalas* who used to supply the city with milk. There is no outside body in it. The only outside body is the Government Agricultural Department which has still in its hands the guidance and organisation of the Society. It is a Society of the *gowalas* and for the *gowalas*. The creditable way in which the Provincial Agricultural Department has handled the organisation leads one to hope that in the future the Department will be able in the natural course of progress to transfer even the organisation and guidance work to the *gowalas* themselves, the Department's function being simply to watch. That would be the consummation of a noble endeavour.

"...The Society makes hay for the summer use, arranges for cheap supply of cattle feeds, and also composts farm yard manure for sale. This constitutes an important additional source of

income to the Society. It also does humanitarian work, e.g., supply of free medicines to the poor and running a school for the children of those residing at or near the Telinkheri Farm. Incidentally, it may be mentioned that the organisation and guidance of this Society has been in the hands of the local Agricultural Department and not the Co-operative Department.”—(*Milk Marketing Report*. P. 195).

The Agricultural Department has done much by way of material help to the Society by initially allowing a vast piece of grazing land and later on “by transferring all farm buildings, cattle sheds, godowns, grazing lands, dairy buildings, utensils etc., to the Society as an experimental measure for 5 years on Rs. 3,830/- per annum.”—(*Milk Marketing Report* P. 194). But for Government help the Society may not have been successful. But the Government has extended every possible help to other societies also. The difference between these and the Telinkheri Society is that the actual milk suppliers of the city constitute this Society. The Agricultural Department organised these natural milk suppliers owning their own cattle who had the milk supply business as their principal occupation. There lay the seed of success. (333)

1206. Gowalas organised likely to play their part honestly: Suppose that the *gowalas* of Bombay or Calcutta were organised, were given sufficient land to live outside the city and allowed to care for their cattle, graze them, feed them, and get an assured profit in an honest way, the same profit

that they make today dishonestly through vicious competition. Then human nature, aspiring for uplift, will make the *gowalas* swing round to the new arrangement which will make them earn honest money without competition and without perpetrating cruelty and torture on the animals, and fraud on the consumers. The Telinkheri Society is an exception. It shows how the Milk Societies have been miserable failures as co-operative organisations, despite the lavish care bestowed on them by the Government Co-operative Department. The tinselled Milk Co-operative Societies cannot help themselves to walk straight, far less help the cows and the consumers.

1207. Urban supply scheme of the Marketing Report : Something better should be done to arrange for pure milk supply to the urban areas, pure in every sense, pure milk rich in vitamins, free from contamination and adulteration, pure in its freshness due to pasture feeding and supplied direct, pure in saving the life of the cows and the calves, pure in the prevention of waste in its production by providing the utilisation of liquid and solid manures. Some better ways should be found. This brings us to a consideration of the scheme which the Milk Marketing Report has described with draft regulations concerning it for adoption by the Provincial Governments.

The report describes the miserable condition of urban milk supply on account of the insanitary condition of milk production and for its widespread adulteration, and distribution through petty and ignorant dealers. It finds that there are inherent

defects in the Food Adulteration Acts and points out that the administration of law is unsatisfactory.

The co-operative societies are unsuccessful private dairy enterprises for supplying pure milk. The endeavours of the Bombay Corporation to improve matters even by grant of subsidies have proved fruitless.

Under the circumstances the Report proposed new legislation on milk. The object of such legislation would be to stop the production of milk in urban areas by making the keeping of cows within the Municipal limits illegal. The next substantial step is to create a monopolist body for milk supply. This body will produce or secure milk from rural areas under sanitary conditions and bring the milk to town depots where it will be distributed to retailers after chilling, while some quantity may be pasteurised. From the central depots of the monopolist organisation, licensed parties will take milk for distribution to consumers ; they may be *halwais* or retailers.

The monopolist organisation will see to the quality of milk. The licensed retailer's work will be checked by taking occasional samples, and if any adulteration is detected, the offender is to be punished. If there are three convictions against a dealer, his licence will be forfeited.

The management of milk supply will be in the hands of the milk marketing organisation.

All prices, including retail prices, will be fixed in consultation with the interests concerned. Animals in the villages will be milked under the supervision of a staff paid by the marketing organisation.

The Municipality will take its share of responsibility for the quality of milk and will license the retailers. The first charge on profits will be the payment of a dividend of 6 per cent. After deducting depreciation and interest, 33 per cent of the remainder shall be carried to the reserve fund, and up to 40 per cent may be returned to the producers as bonus.

1208. Monopolist organisations to supply cities : The principal feature of the scheme is the monopolisation of milk supply by the Government Marketing Department, which monopoly may be ultimately transferred to a private body when such a private organisation is built up with the necessary capital and under the conditions laid down by the Government. The Report supposes that in the beginning the Government or the Municipality or both will have to invest capital in the first seven experimental centres to be opened at Karachi, Delhi, Bombay, Madras, Calcutta, Cawnpore and Nagpur.

The capital necessary for the scheme is estimated at Rs. 4½ lakhs for a daily supply of 1,000 mds, suitable for a city having a population of 2 lakhs and calculates that the investment will be at less than Rs. 3/- per head of population.

Apart from the monopolistic character of the proposed change, the other point is that the matter of fixation of price will rest with the monopolists in consultation with the interests concerned.

The co-operative schemes have proved failures. The present scheme substitutes in the first instance something like the Milk Marketing Department of the

Government in place of the Co-operative Department. But a change in name is likely to do little. The Co-operative Department is a Government Department. If the milk supply arrangement made under its supervision through one or other of the most important co-operative organisations is enquired into by an independent body, then the reason for the public apathy towards these bodies may be properly understood. The substitution of one Departmental control for another with vastly greater powers is not commendable.

1209. A milk union charging $2\frac{1}{3}$ times cost :
The co-operative societies work with a slackness which it is for the Government Department to rectify. Some insight into their working is provided by the Milk Marketing Report. The Calcutta Union, for example, buys milk from producers under the following system :

“...In 1940, the price received by the producers from January to June was Rs. 4/8/- and from June to December Rs. 5/12/- per maund. But the societies receive milk from the members at the rate of 100 tolas per seer, whereas they deliver to the Union at 80 tolas per seer.”—(P. 185)

This shows that the primary societies initially kept a 20% margin over buying. It is to be supposed that this is spent for the local expenses of collection and supervision. After this at the rate mentioned, i.e., at the averaged rate of Rs. 5/2/- per maund, milk is purchased by the Union from societies. It pays railway fare and incurs establishment cost and cost of pasteurising and sells milk which cost it

Rs. 5/2/- at Rs. 10/- per maund to ordinary customers, at Rs. 7/6/- to hospitals and at a special rate of Rs. 8/- to the Municipal Corporation. "Thus the average sale price of all milk handled by the Union is about Rs. 7/12/- per maund."—(*Milk Marketing Report*)

Let us calculate :

The producer received on the average Rs. 5/2/- (average of the two half yearly rates of Rs. 4/8/- and Rs. 5/12/-) per maund of a measure of 100 tolas to the seer. For the standard seer of 80 tolas, the producer, therefore, receives 65·6 annas per maund. The milk is brought down to Calcutta and pasteurised and is distributed to customers at an average price of Rs. 7/12/- or 124 annas.

Therefore, milk costing 65·6 annas at origin is sold at 124 annas, or at about a 100 per cent margin.

This is not all. Pure milk is supposed to be obtained from the cows by the Calcutta Union and its member societies. This milk, as it comes from the cows' udder, should contain 4·5 per cent fat.

The milk sold by the Calcutta Milk Union is supposed to be standard milk of 3·5 per cent fat-content. If this supposition is correct then the milk is toned down from 4·5 per cent to 3·5. Thus, another large percentage is kept as margin. The price realised per maund (of 80 tola seer) by the Co-operative Union is not, therefore, Rs. 7/12/- or 124 annas but 151 annas on the supposition that the standard milk of 3·5 per cent fat-content is supplied.

On the above basis the producers' price of 65·6 annas advances to 151 annas average charged on

the public, which means putting a margin of over 130 per cent over cost or nearly $2\frac{1}{2}$ times the cost.

1210. Toning down or adulteration : Another material fact arises when an Union tones down its milk, say, to 3·5 per cent fat. The Food Act does not provide for addition of water or skimmed milk. Milk is defined to be the fluid coming out from the udder. The minimum percentage of fat allowed is 3·5. But this does not mean that the law permits adulteration of milk with water or skimmed milk. The Milk Marketing scheme also pre-supposes toning down to a standard.

If this toning down is permitted under Government supervision, then the public has a just grievance against such supervision. The scheme which has been formulated in the Milk Marketing Report is for a monopolistic organisation. If it be under such supervision and if it makes such allowance of margin, it has little to commend itself. Before any Government Department steps in to clean the milk marketing system, it is the duty of the Government to show its ability and its desire in this direction by improvement of the condition of the working of the Co-operative Milk Societies and the Co-operative Milk Unions.

There are hardly any reasonable grounds for the Provincial Governments or the Municipalities accepting and adopting the scheme suggested in the Milk Marketing Report. Monopolistic organisations are not likely to improve the situation.

1211. Example of Telinkheri : At this stage Telinkheri may stand as a pointer. The work ahead is

the fostering of an organisation of real milk producers for cities, to make them combine, to save them from mutual, pernicious price competition by fixing minimum price of milk according to fat and S. N. F. content, to insist on declaration of fat-content by every licensed producer and dealer, to arrange for cow milk and buffalo milk to be sold separately as received from the animals' udder, to provide ample land outside cities for healthy keeping and pasturage for cows, to prohibit cow-keeping within Municipal limits. Steps have to be taken to accomplish all these.

In planning for milk supply, all schemes so far considered have been framed from fractional points of view. So large a thing as the supply of milk to the urban population should be on a broad basis to start with. Schemes must first of all ensure satisfactory price for the producer. Cheapness should not be the aim but fairness. Milk price should be fixed after allowing fair cost, fair price and profits to the producer, to the dealer and to the retailer. The health of the cows and the proper maintenance of the cow and the calf should be looked into whatever be the source of supply and how far away be it situated. The milk providing agency should see to it that the urine and dung of the cow is properly handled and utilised. None of these links should be missed. The dry and old and disabled cows will have to be taken care of. These can be developed by making conditions suitable for the city *gowalas* to be removed outside towns, suitable for the rural *gowalas* also, and for the peasant proprietors of milch cows in the *mofussil*,

who cater for the city supply, so that all may find their healthy place in this big job.

1212. Rushing milk out from villages : No good can come out of arranging to rush cheap milk into towns through the extension of cheap and convenient transport service by railways. The I. C. A. R. has been contemplating a movement in this direction. It would be unusual if it had been any thing different. The I. C. A. R. proposed that—

“The Railway Board should be asked to enquire from different railways as to the minimum quantity of milk and the minimum distance over which it would be carried to enable them to grant concession rates for the transport of milk from rural to urban areas. Concrete proposals could then be made for specified routes after the receipt of their reply.” To this the Railway Board have reported that they will undertake the enquiry asked for on this item after the war.—(*I. C. A. R. Report, 1941-'42. P. 53*).

Knowing as the I. C. A. R. does that milk prices do not pay their way, and interested as the I. C. A. R. is in the welfare of the cattle population, it should not help the exploitation of rural poverty for the benefit of the urban population, Quicker, better, cheaper service and refrigerated railway coach service between rural centres and towns for milk collection, are bound to enfeeble the rural cattle and the rural people all the more, unless accompanied by a safeguard for ensuring fair and profitable price for milk. One cannot have both—cheap milk and fairly-produced

milk. Our ideology of commercial transactions should swing from cheapness to fairness and justness. Fair prices and just prices should prevail; "price" would be synonymous with "fair price." For, what is unjust price and unfair price will, in spite of its cheapness, affect the parties adversely and will not be cheap ultimately.

1213. **The producer villages need protection :** At one time Holland was exporting butter without restriction. After sometime this led to the children suffering from want of vitamin A which left the country with the butter. The children were developing *keratomalacia*. The export of butter was restricted. The disease disappeared.

What Holland did every country would do to safeguard the health of its own population by restriction on the undue passing out of nutritious materials essential for the producers themselves. Milk is being swept out of the country to the towns. The Milk Marketing Report gives only glimpses from which it appears that 11 per cent of urban population of the country may be consuming 50 per cent of the total milk production or more. It is necessary that the rural population should be saved from this ruinous condition of things, and schemes for further draining of the milk from villages should be discouraged.

1214. **Standard milk is adulterated milk :** The Food Acts provide that—

"Milk is the normal clean, fresh secretion obtained by complete milking of the healthy cow." —

After this definition comes the enumeration of fat percentage and S. N. F. specification which is

3 per cent to 3·5 per cent fat and 8·5 per cent S. N. F. in most of the provinces. It has been the practice to ignore the first portion of the Act, that milk should be the normal secretion. Where the Municipality prosecutes for adulteration it takes care only to see if the fat percentage and the total S. N. F. are within the legal standard. The practice, therefore, has grown for the more educated and clever people to adulterate milk up to the legal standard of fat and S. N. F. That such practice is not legal is not emphasised and persons sell toned-down milk as genuine milk. The Milk Marketing Report mentioned this fact.

“At present there are generally three standards for whole-milk prescribed under the Food Adulteration Acts, viz., cow, buffalo, and mixed. But the available information shows that there is vast difference between the legal limits of fat and solids-not-fat prescribed in each case and that actually found in the average composition of Indian milk. The result is that heavily adulterated buffalo milk can pass the standard of genuine buffalo milk, genuine cow milk or of mixed milk. In no other country such a position occurs. They may have only one type of milk, viz., cow, but the difference between its natural composition and presumptive legal standard is very narrow.

“Further, it is observed that very few consumers ever get in the open market genuine buffalo milk (over 6·5 per cent fat) or genuine cow milk (over 4·5 per cent fat). The bulk of the supply is mixed milk which may consist of all types of milk and

added water. The milk supplied by the specialised dairy farms is mostly standardised, but in their case a minimum fat-content according to the legal standards may be safely expected."

The Milk Marketing Report mentions the case of specialised Dairy Farms, who supply mostly standardised milk. In this must be included the Co-operative Milk Societies also. Whatever they be, adulteration of the natural secretion from the cow's udder is an adulteration in substance and in law as it exists today. The standard has to be changed to conform to the natural and pure milk.

CHAPTER XXIX

THE BETTER DAIRY SCHEME

1215. The better dairy scheme : Friends have, before this, come to me to ask for schemes for the urban supply of milk as a profitable business undertaking. The perusal of this book may urge others to seek guidance in starting dairy concerns for urban milk supply, moved by the profit motive.

There is an unsatisfied demand for milk in the towns. Genuine milk is a rare commodity. It is, therefore, natural that capable persons having their own capital or having the capacity to collect capital should like to take up dairying as a business venture. The following lines are by way of information to such enterprisers.

When you have your own capital to invest, ask yourself if you have the requisite training to take up dairying as a profession, because dairying, like all other professions, requires training. It is true that every peasant is a dairy man. But it is also true that the peasant has his training from his birth. He knows the habits of the cow, he knows her requirements and he knows how to meet them within his resources. He knows also how to rear a calf, and what to do when there is an attack of disease. He may not know all that you may have learnt by reading books or for the matter of that from this book, but he has a sort

of training ingrained in his very nature. If you know more about cows from books than he does, you may do better than he, but you must have to go through a fraction of his experience. Therefore, any person having capital to invest and time to devote wholly to a dairy enterprise, should postpone undertaking a venture till he has acquired the necessary experience by working in some dairy. Such experience is one of the first requisites to fit one for undertaking a dairy enterprise.

It may be that a person has capital to invest and wants to start a dairy with the help of an experienced man in the line. Such a combination is workable, provided the actual manager shares the views and ideas of the owner of the venture. In the better dairy of the future, mere seeking of profits will not do, and is not to be encouraged. Without any regard for the normal responsibility involved in dairying, in the present condition of our urban milk supply, no body should want to take up dairying. I would advise persons desiring to make profits by dairying to leave dairying alone and satisfy their profit-making needs in other directions, should they listen to me.

But there are men who would like to take up what I would like to call—the better dairying. If you are such a person, you will be able to make your own scheme for starting a dairy after you have gathered the necessary experience.

For the better dairying what is necessary is to have consumers of milk who are prepared to pay the fair price of milk and not the competitive price. The

extent of business will depend upon the circle of such customers. You have to educate your customers. They may not know the difference between an ordinary profit-making dairy and the better-dairy advocated here. You know what it is, if you have gone through the foregoing pages. You have to educate your future customers.

1216. A talk to the customer : You have to tell your customers that you are going to supply them pure and wholesome and genuine milk at fair price, but your price will be higher than the price charged by the man who comes to their doors in the morning and the evening with his milch cow, and milks the animal in their presence. He surely supplies genuine milk, and yet your price will be higher than that of his. As regards quality there will apparently be no difference, but we shall come to that later on. Under the existing arrangements the customer has the satisfaction of seeing the cow when it is being milked, so that nothing can go wrong, and in your case you will supply from a distant place, ready-milked stuff, and your price will be higher. This will be questioned.

1217. Cheap milk and cow slaughter : You will have to explain to him that what he has been buying is genuine milk, but milk, which the late Imperial Dairy expert, Mr. W. Smith, called as being obtained by the "*cow feeding system of milk production.*" That milk feeds the slaughter-house with the cow now standing before the buyer of the milk. The price he pays for the milk is cheap because that itinerant *gowala* will not maintain the cow after she is dry.

It will be cheaper for that *gowala* to let that cow go to the slaughter-house when dry and buy a fresh one for you. He has no place to keep a dry cow. The slaughter-house is only an extension of his cow-shed. Your prospective customer gets genuine milk cheaply, but at the cost of the cow. The customer wants cheap, and the *gowala* also maintains a cow cheap by taking the aid of the slaughter-house. If your customer still wants cheap milk then you have to bid good-bye to him and seek another door. But you may not leave him so soon, and may argue it out with him a little more.

1218. The vitamin-less milk : Tell your prospective customer that the main difference so far as scientific knowledge of nutrition at the present moment goes between ordinary cocoanut oil and the fat from cow-milk is in the vitamin content of the milk-fat. The cheap genuine milk milked in the presence of the customer contains little or no vitamin. Vitamin in milk comes through the feeding of green grass. If the full quota of green grass is not fed it will not make much difference in the milk-yield of one lactation provided concentrates are fed in full. The travelling milker may be giving his cow all the best concentrates to get the utmost yield of milk, but he is not giving a substance which gives the milk its life-giving quality. You will ensure that. In your better dairying you will feed your cows with plenty of green stuff, for, without green feed not only will the milk be vitamin-less, but the health of the cow will gradually go down and she will not be able

to bear a calf, and if she does bear a calf, that calf is likely to be blind and short-lived. Therefore, as you want to serve the cow and her progeny, you will have to feed your cow with green grass and thus ensure full vitamin flow in the milk. Milk will be worth the more for the vitamin which your prospective customer does not get today, even by having the cow milked in his presence. This talk may work on your prospective customer. But you have not exhausted all your arguments for his patronage to our better dairy.

1219. The starved-to-death calf : You will tell your prospective customer that the calf he sees before him is sure to be allowed to die of starvation. Already the calf is under-fed, and soon the calf will die. The *gowala* will keep that cow in his shed for milking her there, and bring another cow or train another new-born calf to suck from the old cow to let down her milk. The calf is allowed to die. Because, for the first month the calf cannot digest anything but milk. The *gowala* cannot think of giving any milk to the calf. He has to sell every drop, and he does not want the calf either. The calf, deprived of the minimum requisite quantity of milk and in its inability to digest anything but milk, starves, and then develops one disease or another, or simply dies. The *gowala* does not suffer. He stuffs the skin of the calf, which he calls a "*tashbir*". He places that before the cow at the time of milking and the cow lets down her milk. True, he cannot carry about the "*tashbir*" to the customers' door, therefore he trains another calf to suck. But if this does not succeed, he keeps that cow

in the stall and gets her milked in the stall, and brings a fresh cow to you. The *gowala* sells more milk than what he draws from cows at the customers' houses. He is no loser. He starves the calf for profit and not for loss.

1220. The real character of city cow's milk : Supposing the calf is very fortunate and outlives the lactation period, still it has to die of starvation. What use has the *gowala* for the calf ? None whatsoever. And there is no future for the calf either. The calf, so neglected in early life, will neither make a good bullock nor a good heifer. In fact, the calves of the town milch cows never escape death from starvation. There is no room to maintain them. They go to Dhappa—if it is Calcutta, and they go to Chemur—if it is Bombay. You may take your prospective customer to Dhappa, to the carcass-disposal yard of Messrs Shaw Wallace and Co., the Municipal contractors for receiving dead cattle, or to the Howrah Belgachhia carcass disposal grounds of the Khadi Pratisthan to see the daily collection of dead calves. If you are at Bombay, you may take your client to the Mahaluxmi terminus of the scavenging train for Chemur. If you yourself have not seen these places, see them. You and your prospective customer should know that the cheap but genuine milk of the city is :

- (1) Cow-eating milk—a milk that eats up the cow by sending it to the slaughter-house.
- (2) Lifeless milk—milk that is void of vitamins.
- (3) Calf-eating milk—milk that eats up the calf and allows it to be starved to death.

If your prospective buyer has patience, you will tell him that in city dairies the calves under the best management are allowed to be starved or sold to the butchers. It does not pay to rear a calf. You have learnt all about the cost of rearing a calf. When it is reared under city conditions, the cost is prohibitive, and it cannot be sold even at half the cost of maintenance.

The calves, if they are to be saved, are to be reared cheap, and this can be done where there is provision for grazing. The same thing applies to the cows. Land is necessary to maintain the cow and her calf, and with all that it is costly. A better dairy placed away from the city, with sufficient land, can accomplish this and save the cow and her calf, of course, at the cost of some milk. The man who keeps his milch cow in the town can save neither the cow nor the calf ; both die prematurely.

1221. The four-fold yajna in dairying : But this is not all. Tell him about the national loss in allowing the urine and dung to be wasted, as is done in the towns. The urine has to be preserved and returned to the soil and the dung also. When all these are done, when the life of the cow is guaranteed for the normal span, when the calves are fed and reared, when the urine and dung go to enrich the soil, multiplied by conversion into composts, there is a four-fold *yajna* or sacrifice :

(1) The cow and her progeny are served and saved.

(2) The soil is served by urine, dung and compost.

(3) The plant is served by better soil-fertility.

(4) Man is served by milk, by cattle labour, and from the greater yield of crops.

This is the four-fold *yajna*, and your better-dairy promises to do all this and sell costlier milk for doing this. If your prospective customer has faith in your programme and in you, then have him and have others like him, and upon the strength of such support, venture out for making an estimate for establishing a better-dairy.

Make your estimate on the basis of the requirements of your prospective customers. The quantity of milk needed has to be ascertained. From this you come to the number of cows. This will depend upon your selection of the breed.

1222. The basis of cost calculation in better dairying : When you have calculated the number of milch animals to be kept, allowed for their dry period and also for their old age maintenance, and made a total calculation of the number of dry and milch cows to be maintained at any time in the dairy farm, allowed for the bull and for the calves, and for the bullocks employed in cultivation to grow your fodder and concentrates, you get a total of the animals. Allow for their feeding cost, for the labour of attending on them and for the milk delivery expenses. Allow for accidental loss of animals from disease. All this will go to the cost side.

Calculate the extent of acreage necessary for keeping the herd partly on stall-feeding and partly on grazing. Allow for land for growing fodder and for

erecting sheds. Provide for expenses for making the land fit for a dairy farm with fencing etc. You will be able to make an idea from all this about the requirement of initial capital, about expenses and depreciation and about costs. Strike a balance against your output of milk and increased value of the stock on the one side, and the expenses and depreciation and interest on the other. The estimate will pre-suppose your having a proper piece of land. Select the land and base your estimate on the supposition of your getting the plot.

You will then know at what price you have to sell your milk to your customers for making the four-fold *yajna* complete. Show your prospective customers the estimates. If they approve, have your estimate examined by those who have had experience of the items involved. You may not get a single person to examine critically all the details, you may have to approach several experienced men for their help in judging your scheme and estimate. Revise the estimate in the light of the criticisms offered.

Then put the corrected estimate again before your customers, and with their approval go forth with the work. Proceed cautiously. Make a small beginning and expand as you feel your way. Let your *yajna* be a pure one in word and deed, and you will not be endeavouring in vain.

1223. The reformer in the village : What I have asked you to address to your customers is really to yourself also. If you do not get any customer outside, you will get at least one, in yourself. Do not be

daunted at the paucity of customers. Strive for the single customer in yourself. Even then, if you have the capacity, God willing, you will succeed. And, if you cannot succeed with the prospective single customer in yourself, a whole listful of customers will be meaningless to you and will be of no avail. The consciousness of strength must come from within you. Begin the *yajna* for yourself.

Urban supply will have attracted you. If you do not get urban support, choose your village and work on with your *yajna*. You need the dairy for yourself. Customers are secondary. Such a dairy, as sketched above, is a type of mixed farming. A farming in which your wife and child can help you. Then you become a family of peasants, of cultivators, and carry on the *yajna* in its purest form in your village home. Maintain the cows in the *yajnic* spirit, and they will maintain you and your family, provided that the family also serves the cow, the soil and the plants with you. The joy of feeling yourself in unison with soil, plant and animal life will be yours. You will be realising in your life a noble dream, translated into reality.

CHAPTER XXX

THE DAIRY ACCOUNTS.

1224. Dairy management books : For management of a dairy, a set of books has to be kept. These are dairy management accounts, and are concerned mainly with helping milk production and better dairying.

These account-books and forms will be guides for proper management. The dairy manager ought to know how he is placed with the cows, how many are coming to calve next month, and how many will calve eight or nine months ahead. He has to know the milking performance of each cow in order to be able to feed her to the best profit. He will have to be able to say how many calves there are and between what ranges of age. He ought to know what stock of fodder and concentrates he has and what would be the requirements in the near future. He will then be able to stock his straw or hay and make necessary arrangements for green feed throughout the year. These and many more details have to be kept ready, so that everything may be got at a moment's notice and at a glance without having to go about searching and questioning others for information. The books are simple to be kept, once the method is understood, and are indispensable for proper dairy management.

A. Control-Book.

The control-book will have several sections :

- (1) Register of dairy cows ;
- (2) Register of female calves ;
- (3) Register of male calves ;
- (4) Register of pregnant cows :
- (5) Register of empty cows ;
- (6) Lactation register ;
- (7) Register of bulls and bullocks ;
- (8) Master roll.

B. Herd Register.

- (1) For cows ;
- (2) For female calves ;
- (3) For male calves ;
- (4) For bulls.

*C. Daily Milk Register.**D. Fodder Register.**E. Receipt and Issue-Book for Fodders.**F. Events Register.**G. Day-Book of Events, Milk-yields,
and Fodder-consumption.**H. Monthly Report-form.**I. Labour Attendance Register.*

1225. CONTROL BOOK :

Section 1. Register of dairy cows.

(Continued to right page—

1	2	3	4	5	6	7
Herd- book No.	Cow No. serial.	Name of cow.	Pedigree.	Date of birth.	Age by dots.	No. of issues by dots.
15	16	Janaki	...	15.2.38	...	..
		{ Dam—Godavri—		{ Sumitra	...	..
		{ Sire— Raja		{ Nandi	...	..

Instruction for filling the columns. At the right hand corner put the year and 1. 2. etc., indicating the month up to which the Register is posted. Column as under :

- (1) Put the No. from the Herd Register Book.
- (2) Put the serial No. for the year beginning with the oldest cow in the herd. This book is to be replaced every year, so that every year begins with a new serial number, after the changes in the last year caused by death or sale or the heifer's coming into the list.
- (3) Name of the cow. Each individual shall have a name.
- (4) Pedigree. The name of the dam and sire are put so far as is known.
- (5) Date of birth.
- (6) Age. Put dots, so that at any time in the year,

CONTROL BOOK :**Section 1. Register of dairy cows.**

—Continued from left page)

Posted up to.....1943. 1. 2. 3. 4. 5.....				
8	9	10	11	12
Description of lactations.	Date of cover.	Covered by.	Date of delivery.	Months empty or pregnant.
(1) Lalmani. Dt.....of birth. Lactation 27 mds. 29 seers. Highest day 5 seers.				
(2) Sukumar. Dt.....of birth. Lactation 29½ mds. Highest day 6 seers.				
(3) Bharati etc. etc.				
(4) Sundari.				
(5) Narayan.				

by completion of the year, you have simply to add a dot without having to go through a number. In the example the age is 9 years.

- (7) No. of issues by dots. For reasons of No. 6 put number of issues by dots. In the example it is 5.
- (8) Description of lactation. Here put the name of the calf, its date of birth. Total milk received during the lactation. The highest yield of milk on any one day in the second month. There will be space for adding on descriptions of fresh issues.
- (9) When the cow is covered—put date.
- (10) Name of the bull covering the cow.
- (11) When the cow calves—put the date of delivery and put the name of the calf in column 8.
- (12) Months empty or months pregnant. At the time of posting—post the number of empty months by dashes - - - or months pregnant by circles o o o o.

1226. CONTROL BOOK :**Section 2. Register of female calves.**

Posted up to 1943. 1. 2. 3. 4.

1	2	3	4	5	6	7	8
No.	Name.	Pedigree.	Date of birth.	Age.	Date of cover.	Covered by.	Disposal.

Explanation of columns.

- (1) No. of calf according to Herd-Register.
- (2) Name of the calf. The calf should be given name as soon as it is born.
- (3) Pedigree. Put the names of sire and dam and their sire, and again these last ones, so far as is known.
- (4) Put date of birth.
- (5) Put age by dots indicating months, and when 12 dots, meaning 12 months, are completed, connect the dots by a line, indicating a year. Thus :

.....

The lines and dots indicate 2 years and three months.

- (6) Date of cover. When the calf is old enough and gets covered, the date of cover is put.
- (7) Covered by. Put name of the bull.
- (8) Disposal. Transferred to Register of cows after birth of calf, or sold or dead. Put date.

1227. CONTROL BOOK :**Section 3. Register of male calves.**

1	2	3	4	5	6
No.	Name.	Pedigree.	Date of birth.	Age.	Disposal.

- (1) to (5) are the same as for the female calves.
(6) In this column enter—if sold, or castrated or, when of age, transferred to Herd Register—for bulls.

1228. CONTROL BOOK :**Section 4. Register of pregnant cows.**

1	2	3	4	5	6	7	8	9	10
No.	Name.	Age.	Issues.	Date of cover.	Covered by	Expect- ed date of calving.	Date of calv- ing.	No. of days.	Issue.

- (1) Put Pedigree Register No.
- (2) Name.
- (3) Age as entered in Register of cows.
- (4) Issues " " "
- (5) Date of cover. Put date.
- (6) Covered by. Put name of the bull.
- (7) Expected date of delivery. Add 282 days and put date according to calendar as per Table, Para 1016.
- (8) Date of calving. Put actual date.
- (9) No. of days. Put actual number of days elapsed during the gestation period from the day of cover to day of delivery.
- (10) Issue. Put the name of the calf, male or female.

Note :—As soon as a cow delivers, she becomes empty; her name is no longer of significance in this Register. The removal of her name is indicated by a thick line below her name in the manner of underlining. The Register is not penned through. But, if there is no pregnancy and she gets heated, the date of cover is made a fresh entry. The previous entry is cancelled by an under-line. On fresh entry the remark is made as 2nd time covered.

1229. CONTROL BOOK :**Section 5. Register of empty cows.**

Posted up to 1943. 1. 2. ...						
1	2	3	4	5	6	7
No.	Name.	Age.	Issues.	Date of delivery.	Empty months.	Date of cover.

- (1) to (4) To be filled from Register of cows.
- (5) As soon as a cow delivers a calf, her name comes to this Register from the Register of pregnant cows. Put the date of last calving.
- (6) Empty months put by dashes — — — — —. So that at a glance the number of months she is empty can be found out.
- (7) Date of cover. Put date. When she is covered her name goes to the list of pregnant cows—previous form No. 4. The removal of name is indicated not by penning through the name but by a thick underline.

1230. CONTROL BOOK :
Section 6. Lactation Register.

(Continued to right page—

1.	2.	3.	4.	5.	6
No.	Name.	Age.	Issues.	Date of calving.	Lactation—
					1. 2.
					1. Md. Sr. 1. Md. Sr.
					2. Md. Sr. 2. Md. Sr.

- (1) to (5) To be filled from Register of cows.
- (6) Lactation months are sub-divided into 1, 2, 3, etc., indicating months of lactation. These columns are filled in two lines. The first line gives the milk by maunds and seers during the

CONTROL BOOK :**Section 6. Lactation Register.**

—Continued from left page)

Posted up to 1943. 1. 2. 3. 4.

6.						7.	8.
—Months.						Total	Days.
8	4	5	6	7	to 12.	lactation.	
1. Md. Sr.	etc.						
2. Md. Sr.	etc.						

month, the second line gives the total milk up to that month. When the lactation is finished the total is carried again to Column 7.

- (1) Total lactation is put.
- (8) No. of days of lactation is entered.

1231. CONTROL BOOK :**Section 7. Register of bulls.**

Posted up to

1.	2.	3.	4.
Name.	Pedigree.	Date of birth.	Age.

(1) to (3) are to be filled from Herd Register.

(4) Age is put by dots.

Each bull is given a page. The page is filled by record of covers and results as under :

1.	2.	3.	4.
Date of covering.	Cow covered.	Date of delivery.	Date of Re-covering.

In the page, the columns are filled as the cows are covered. When the cow has conceived and she delivers a calf, the dates are entered showing successful cover. When the cow comes to heat again, the date of re-covering is entered both in column 1 and 4.

Register of bullocks.

Posted up to

No.	Name.	Age.	Pedigree.	Disposal.
-----	-------	------	-----------	-----------

The entries are made from the Herd Register.

1232. CONTROL BOOK :**Section 8. Master roll.**

In this book is kept the names of all the animals of the herd, giving date of entry. Whenever there is a change by death, by birth or sale or otherwise, the entry is corrected as on that date.

At every entry a new serial number is put against the animal and a remark for a change.

	Date of entry.	Date of entry.	Date of entry.	etc.
	1-10-40	20-11-40	25-12-40	
<i>Name of the cows.</i>				
Bina	1	1	1	
Nurbada	2	dead	dead	
Jamuna	3	2	2	
Lakshmi			3 purchased	
<i>Name of the female-calves.</i>				
<i>Name of the male-calves.</i>				
<i>Name of the bulls.</i>				

1233. HERD REGISTER :

Section 1. For cows.

Page No.

No. & Name.....	Sire.....	{	G. Sire & Breed	{	<table border="1"> <tr><td></td><td></td><td></td><td></td></tr> <tr><td></td><td></td><td></td><td></td></tr> <tr><td></td><td></td><td></td><td></td></tr> <tr><td></td><td></td><td></td><td></td></tr> </table>																
Breed.....		G. Dam & Breed																			
		Milk yield, lbs.																			
		Days in milk.																			

Dam & Breed.....	{	G. Sire & Breed	{	<table border="1"> <tr><td></td><td></td><td></td><td></td></tr> <tr><td></td><td></td><td></td><td></td></tr> <tr><td></td><td></td><td></td><td></td></tr> <tr><td></td><td></td><td></td><td></td></tr> </table>																
	G. Dam & Breed																			
	Milk yield, lbs.																			
	Days in milk.																			

Milk yield of the cow : Milk Yield, lbs.

Days in Milk.

Date of calving

Born on (Date).....at (Place).....

Purchased on (Date).....by.....from.....at Rs.....Age at purchase.....

Initial Value Rs.....	Subsequent valuations	{	Year	{	<table border="1"> <tr><td></td><td></td><td></td><td></td><td></td><td></td></tr> <tr><td></td><td></td><td></td><td></td><td></td><td></td></tr> <tr><td></td><td></td><td></td><td></td><td></td><td></td></tr> <tr><td></td><td></td><td></td><td></td><td></td><td></td></tr> </table>																								
		Rs.																											

Note :—This book is a permanent book and should be carefully kept. The Control-Register is renewed from year to year and is kept in the Dairy Yard. The Herd Register is kept in the office. Once a month the entries are made from the Control Book.

1234. HERD REGISTER :**Section 2. For calves—female.**

The form is practically the same as for cows. Only female-calves are entered in this book and are transferred to Cow Register on calving.

HERD REGISTER :**Section 3. For calves—male.**

Same as for female calves.

HERD REGISTER :**Section 4. For bulls.**

Same as for the Register for bulls.

(See Control Book, Section 7).

1235. DAILY MILK REGISTER

1	2	3			4
Name of cows.	Date calving.	1	2	3	4
		1	2	3	4
		5	6	7	8
		9	10	11	12
		13	14	15	16
		17	18	19	20
		21	22	23	24
		25	26	27	28
		29	30	Total.	

(1) Name of cow.

(2) Date of calving of cow.

(3) Daily milk production is entered from the Rough Day-book. The Rough Day-Book gives both morning and evening entries and a total for the day; in this book only the day's total is entered. In order that one foolscap sheet lengthwise may hold 30 days entry, the columns are made small. The entries for milk are entered in the short space by seers in one line and quarter-seers by 1, 2, 3, on top of the seers. Thus 5² indicate 5 seers and 2 quarter seers or 5½ seers. Similarly, 3³ or 4¹ indicate 3 seers 12 chhataks and 4 seers 4 chhataks. Fractions are not put in the Primary Book and also here; they are neglected. The milk total for all cows while milking is adjusted with a view to the neglecting of fractions of ¼ seers.

(4) At the end of the month the total for the month per cow is put, while at the end of the day's column the daily total is put, and the last entry after the end of the month will be the monthly total of the day's totals or total milk-yield for the month.

1236. FODDER REGISTER :

1	2	3	4	5
Items.	Unit.	Rate.	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30	Total.

Straw. Mds.
Kalai. Seers.

(1) Items are put in column.

(2) The unit of expenditure day to day to be put either in seers or maunds.

(3) Rate per unit of the items are put.

(4) 30 entries are made in one sheet for the month. The same mode is adopted for saving space as in the case of milk out-put entries. Whole and one-fourth fractions of seers are entered or maunds and one-fourth maunds are entered. The expenses are made so as to satisfy this sort of entry. Fractions are not issued. As the issue is in a lump for the whole herd this can be easily managed by indenting rations in not less than fraction of one-fourth seers or one-fourth maunds as the unit is chosen. The costing is made from this book at the end of the month as checked with the Stock-Book for fodder.

(5) At the end of the month the total for each item is put.

1237. RECEIPT AND ISSUE-BOOK FOR FODDERS :

This is the usual commercial pattern of book, giving receipts, issues and balances of stock. This book is checked with the Fodder Register.

1238. EVENTS REGISTER :

1	2
Date.	Event.

- (1) The date is put.
- (2) Whatever happens in the day is entered from the Day-Book, in which milk and fodder are also entered. Births, deaths, illness, treatment, call of Vet., or any special event is entered. From this the Monthly Report is posted, showing the events.

1239. DAY-BOOK FOR ENTRY OF EVENTS, MILK-YIELDS AND FODDER-CONSUMPTION :

- (1) Milk is entered name by name of the cows and three columns are given to a day as under :

1.	2.	3.	4.	5.	6.	7.	8.
Name of cow.	Date.	M.E.T.	M.E.T.				

Under M. E. T. Morning milk, Evening milk and the Total milk for the day are entered. The system of entering is by seers and their quarters.

- (2) Fodder is entered day to day. Same as in Fodder Register which is posted from this section of the Day-Book.

- (3) Events Register Day-Book.

A section of the Day-Book is set apart for registering daily events as they happen for posting in the Events Register.

This book is a rough book and may be kept in pencil, for all the entries are copied out in fair in other books.

1240. MONTHLY REPORT FORM :

Report for the month of

(1) Events Register.

(2) Milk Yields.

1	2	3	4	5	6
Name of cows	Date of calving.	Previous yield,	Yield during the month.	Yield up to end of month.	Date of cover.

1 to 6 columns are self-explanatory. The base of column 4 is totalled for all cows, giving monthly total of milk.

This total is divided by number of days milked, giving the average yield per head of the milking cows per day, being the month's average.

(3) Fodder Expenses.

Items.	Monthly expense—quantity.	Rate.	Value.
--------	---------------------------	-------	--------

Total value

The value of monthly total of fodder expenses is shown here.

Monthly Report Form (continued).**(4) Cost per seer of Milk.**

In this space the total milk-yield and the total expenditure on fodders etc. is put and the incidence of maintenance cost on milk-yield is worked out and shown.

(5) Herd position : Total of Master roll.

		Calving expectation.
Total No. of cows.	No. of male calves.	January.
No. of milch cows.	No. of female calves.	February.
No. of pregnant cows.	No. of bulls.	March etc.
No. of empty cows.	No. of bullocks.	

The monthly report is made in five sections as sketched above. The size of paper and ruling should be adopted according to the strength of the herd. More than one sheet may be needed, and for a large herd several sheets may be needed for milk-yield recording only.

This will give all the materials necessary for administration. Here the entire cost of milk production is not attempted to be worked out. The dairy management books give the direct feeding cost of the milk produced.

1241. LABOUR REGISTER :

Labour Register is to be kept at the office.
A subsidiary book is kept at the dairy, for keeping attendance.

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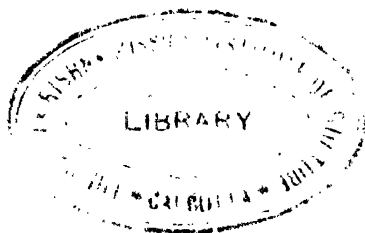
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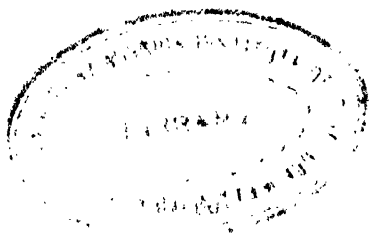
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